E P FABER

PROCEEDINGS

OF

THE ROYAL SOCIETY

OF

EDINBURGH.

VOL. IV.

NOVEMBER 1857 TO APRIL 1862.

EDINBURGH:
PRINTED BY NEILL AND COMPANY.
MDCCCLXII.

CONTENTS.

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OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. IV. 1857–58. No. 48.

SEVENTY-FIFTH SESSION.

Monday, 23d November 1857.

DR CHRISTISON, V.P., in the Chair.

The following Council were elected:—

President.

SIR T. MAKDOUGALL BRISBANE, BT., G.C.B.

Vice-Presidents.

Sir D. BREWSTER, K.H.
Very Rev. Principal LEE.
Right Rev. Bishop TERROT.
Dr CHRISTISON.
Dr ALISON.
Professor KELLAND.

General Secretary,—Professor FORBES.

Secretaries to the Ordinary Meetings,—Dr GREGORY, Dr BALFOUR.

Treasurer,—J. T. GIBSON-CRAIG, Esq.

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WM. SWAN, Esq.
Dr TRAILL.
Hon. Lord NEAVES.
Dr THOMAS ANDERSON.
Rev. Dr HODSON.
ROBERT CHAMBERS, Esq.
JOHN RUSSELL, Esq.
JOHN HILL BURTON, Esq.
DAVID STEVENSON, Esq.
WM. THOS. THOMSON, Esq.
Dr ALLMAN.

Monday, 7th December 1857.

At the request of the Council, Dr CHRISTISON, V.P., delivered the following Address from the Chair:—

On this annual occasion of resuming the Ordinary Meetings of the Royal Society, it becomes us, as almost a duty which we owe to science, and to our country, whose science we in some measure represent, that we should review what has been done by the Society during the past year, to merit the position which it holds in public opinion, and the title which it pre-eminently enjoys.

I believe it may be allowed me to congratulate you on the result of such a retrospect of your proceedings. We cannot, indeed, boast of any great or prominent discovery in the physical or natural sciences having been first announced during last Session in this Hall, or first given to the world in our *Transactions* for that period. But in truth, the past year has been nowhere, to my knowledge, marked by any such event in any country. Nay, for several years it has been scarcely possible to place the finger on any great discovery made by the cultivators of natural and physical science in any quarter of the world. We seem to be living in one of those not uncommon pauses in the progress of science, during which discovery, in its grand signification, is at rest, but in which prior discovery undergoes consolidation, extension, and application; and in which a breathing-time is obtained, and a firm vantage-ground whence, without doubt, another advance will be made ere long to other conquests; and the development, possibly, of new elements and new powers,—but certainly of new generalizations and new laws,—will reward the researches of some higher mind, which, without the preparative works of detail of the present day, might remain barren in discovery and invention.

In such unobtrusive, and yet, as we may be permitted to hope, not unproductive labours, this Society may claim to have taken a fair share. Without referring, as might be justly done, to many papers of a more fugitive or less elaborate character which have been produced to our Ordinary Meetings, it will be sufficient for me to call attention to the recent Fasciculus of our *Transactions* for the year

1856–57, in which the mathematician cannot fail to recognise the acute scrutiny, by Mr Boole, of the Application of the Theory of Probabilities to the question of the Combination of Testimonies or Judgments; or the mechanical philosopher to welcome the contributions of Mr Clerk Maxwell to the Theory of Rotation; or the chemist to admire the continuation of Dr Anderson's Analysis of the Products of the Destructive Distillation of Animal Matters; or the naturalist to wonder at the strange and overwhelming variety of forms of microscopic life, to the unfolding of which so much has been contributed by Dr Gregory's elaborate paper on the Diatomaceæ; or the physiologist to applaud and encourage the ingenuity with which a new and promising inquirer, Mr Lister, has successfully investigated the Minute Structure of Involuntary Muscular Fibre.

Nor has the Society neglected other branches of its vocation. I may, in particular, call your attention to what has been done by your Council towards completing the publication of the "Makerstoun Magnetical and Meteorological Observations." These Observations have been already published down to the year 1846, in three extra volumes of the Society's *Transactions;* but as the observations have been continued since that time almost to the present day,—not, indeed, in such number as previously, but with care and regularity, by the direction of our President, Sir T. M. Brisbane,—it was thought that benefit would accrue to science by continuing the reduction and publication of them. This it has been resolved to carry through on a somewhat abridged plan; towards which object the President has munificently contributed L.200, and the Council, on behalf of the Society, has added an equal sum. Mr Welsh of the Kew Observatory, who was himself observer at Makerstoun for a few years, has favoured the Council by superintending the reductions, which are now in progress.

During the past year the Librarian and Council have continued their exertions to bring the Library into a satisfactory and easily accessible condition. Of the sum of L.300 voted by the Society for the purpose, only a small proportion has been expended in the purchase of a few new works,—works, however, of much interest and value. The greater part of the vote has been applied to completing and binding many previously incomplete works, and in adding to the truly valuable Collection of Maps, which was prominently noticed in the introductory Address of Bishop Terrot last year, as having been begun and advanced far forward, under the kind superintendence of Mr Keith Johnston.

The importance of what has thus been done for the Library, and the value of the collection of books now in the Society's possession, cannot be well appreciated until the publication of the Catalogue, which has been in hand for a longer period than many Members may have thought necessary. It is only those who have been themselves engaged in making a Catalogue that can estimate the time required to carry through such an undertaking well; and to them the time which has been found requisite will not appear too great. When the present Assistant Curator was appointed to his office last year, the Catalogue was actually in type; but in so unsatisfactory a condition, that what had been done may be said to have since been all done over again. During last year it has been almost entirely reconstructed, and much extended; it will be found now, as the Council believe, correct, complete, and worthy of the Society; and it is ready, or nearly so, for publication. The Council, in noticing the completion of this important labour, cannot express too highly the sense they entertain of the services of Dr Lawson, who has applied himself to the task put before him with a zeal, diligence, method, and ability, which lead the Council to congratulate themselves and the Society on the choice which was made in appointing him.

While we may survey, as it appears to me with some satisfaction, these labours of our Society during last session, I will nevertheless take the liberty of observing that, on casting my eye down the List of Fellows which was put before us all, according to custom, at the late annual election of Office-Bearers, it did occur to me to wonder, that so long a catalogue of names, well known in literature and science, should not have produced even more materials for upholding the character and title of the Royal Society of Edinburgh. This list comprises 289 individuals, of whom eighty-nine may be truly considered to be engaged in the pursuit of science, and twenty-four in that of literature; and of the former class there are at least forty-nine, of the latter thirteen, resident in Edinburgh, or not far from it, who have already shown, by their writings and inquiries, that they are well able to maintain and forward the prosperity of literature and science.

I will not pretend to inquire into the causes which, for a few years past, have somehow or another lessened the interest of the meetings of our Society, in face of such apparently ample resources. But, as one means of counteracting them, I may be permitted to point out to all, but especially to the cultivators of science in our northern land, that they are not perhaps fully aware of the advantages to be derived from promulgating their inquiries and discoveries through the medium of the Society's meetings and published *Proceedings* and *Transactions*. It cannot be too well known to them, that our Prizes, founded through the affection and munificence of the late Sir Alexander Keith and Dr Neill, and of our present President, Sir T. M. Brisbane, are sufficiently numerous to hold out a reasonable prospect of substantial public honours for every successful and important investigation ;—that our printed *Proceedings* and *Transactions*, promptly published, and at once widely disseminated by exchange with every distinguished scientific Society in Europe and America, hold out the temptation of easy and extensive advertisement of discoveries and researches ; and that our Meetings supply, in our audiences, an assemblage of men of talent and weight in every rank and profession, who are competent judges of ability, and whose good opinion will ever tend to foster, advance, and reward true merit, especially among the young and aspiring in science. I could mention not a few instances in my own time of men of celebrity, whose first successful step in life rested on the fame acquired for them among the Fellows of this Society by a paper read at its Ordinary Meetings.

But there is also a whole galaxy of names in our list, of men in need of no such encouragement, who pursue science for its own sake alone, and yet who choose other channels than this Society for promulgating their successes. These I beg simply to remind that the Royal Society is no longer the tedious channel, whose former tardiness has probably led to a falling off in the number of important communications to our Meetings ; and farther, that the production of a paper here does not prevent its author from selecting any other medium of communication which he may prefer to our *Transactions*.

In making the survey which has led to these, I trust, neither unseasonable nor unreasonable considerations, my attention has been naturally turned to the changes which the lapse of a short year has created in our List of Fellows. Of the Ordinary Fellows, as the list stood last year, nine have died, and one has resigned. The ordinary list includes 269 Fellows. The newly-elected Fellows are *Horatio Ross, Esq., Dr James Black, Dr John Ivor Murray, The Right Hon. John Melville, Lord Provost, John Blackwood, Esq., Brinsley de Courcy Nixon, Esq., Andrew Murray, Esq., W.S., Rev. Dr Macfarlane, Duddingston, Dr W. M. Buchanan*, and *Thomas Login, Esq., C.E.* Our loss has therefore been exactly replaced, so far as mere number is concerned.

Whether our loss has been replaced in other respects than in mere numbers, is a question which the future only can answer. But if our new members are to take upon themselves the duty of repairing in all respects the casualties of the last twelve months, they have an arduous task before them ; for, among our losses, we have to deplore the deaths of *William Henry Playfair, William Scoresby, Marshall Hall*, and *John Fleming*,—names, than which we can scarcely point to any in the British Islands more estimable in their respective sciences of Architecture, Navigation, Physiology, and Natural History.

In one respect these gentlemen have had a common fate. They have all attained to an advanced age,—dying, except partially in one instance, in the pride of mental vigour, but yet not until each had left behind him works that are likely to be imperishable, so far as the work of man may be so. This consideration casts a ray of sunshine over our gloom of regret at their disappearance from amongst us. But it cannot render our calamity less material, and must only increase our anxiety that their places here may be worthily and speedily filled from the succeeding generations of members.

The other deceased fellows whom I have to mention are *Mr John Dewar*, advocate, *Mr Bald*, civil engineer in London, *Mr John Haldane* of Haddington, *Mr George Forbes*, banker in this city, and *Mr John Adie*, optician in Edinburgh. Of these *Mr Haldane* was known to us as an unobtrusive amateur in natural history, to which he was naturally enough attracted during his long service in earlier life, as an able officer of the Hudson's Bay Company in North America. *Mr Forbes*, one of a family long remarkable in our city for worth and talent, and still represented now more ably than ever in this Society, was for some years our faithful and zealous Treasurer ; and was endeared to many of us as a gentleman of cultivated taste in literature and art, and to the whole community as a man of most amiable disposition, constantly abounding in works of active practical benevolence. *Mr Adie's* enrolment among us is sufficient proof that he successfully followed his calling as one of the scientific arts; and by those by whom he must be better appreciated than by myself, he was greatly esteemed as a man conversant with the highest branches of his profession, and who has left behind him in that respect scarcely an equal, certainly no superior, in Edinburgh, or perhaps even in London itself.

The four pre-eminent men whose names I mentioned in the first instance, demand from us much more than a simple passing notice. I wish that I were competent, and your present leisure sufficient, for the full biography which is necessary to do them complete justice. I am sure, however, that you will welcome some present short tribute of respect to their memory; and that you will excuse my shortcomings on a field of great extent, which I have had unfortunately but very brief opportunities of leisure to survey, and on which, indeed, I should on that account have been compelled to decline entering, had it not been for the kindness of sundry Members of Council who have furnished me with the necessary means.

William Henry Playfair, a Scotchman by descent, and a citizen of Edinburgh from his youth, was born in London, where his father, the brother of our former Professor, Philosopher, and Secretary, John Playfair, practised as an architect of repute. Educated here under the eye of his uncle, and living much in the society of a host of his uncle's pupils, comprising a multitude of young men of talent, who have since risen to great eminence in many departments of human knowledge, Mr Playfair acquired an extensive acquaintance with Learning, Science, and Art, and above all, in his own profession, a correct and fastidious taste, of which we now reap the fruits in this city.

At the early age of twenty-six Mr Playfair was chosen by His Majesty George the Third's Commissioners to carry out the erection of the buildings for the University,—his first great work, in which he was at one and the same time aided by the general grandeur, and cramped by the faulty details, of his precursor Adam,—and in which he ultimately triumphed over every difficulty. There is nothing in our northern metropolis to compare with the simple stateliness and chaste details of the interior quadrangle of the University,—which is mainly Playfair's own,—for his predecessor contemplated the monstrous and fatal blot of a double quadrangle, with differently elevated courts;—and we have nowhere else any single apartment that combines so chastely and harmoniously the vastness of space, architectural splendour, and bibliothecal fitness of the upper Library Hall.

It would be out of place for me to notice here all Playfair's public works; which have been principally erected in Edinburgh, constitute a large proportion of the most conspicuous architectural decorations of the city, and bid fair to immortalize him, so long as the capital of Scotland shall continue to attract, as it does now, visitors of taste from all quarters of Europe and America. Among critics in architecture it may be wished that some of them were better. But was it the architect's fault that they are not so? In every one of his works, except Donaldson's Hospital, he had to encounter great difficulties of site, or neighbourhood, or both together,—difficulties, indeed, sometimes unconquerable by any skill. And yet even in these, when he is said to have failed, the critics who think so appear to me to proceed for the most part upon the assumption, that he had within his choice plans of far greater magnitude than his limits, and a command of means far beyond his actual treasury. Who, for instance, can say what might not have been the felicity of an architect, so pure in his style, and so fruitful in his resources, had he been told when he designed the columned temple in a portion of which our Society is now accommodated, that he was afterwards to cover the Mound, from the bottom to the crown of its slope, with public edifices?—and that he was at liberty to do so at a cost of twice, thrice, or four times the L.100,000 which have been actually expended on them?—for that seems conditional to the criticisms to which one often hears Playfair subjected, on account of his designs for the Royal Institution's Building, the National Gallery, and the Free Church College.

Of all his works none has called forth such unqualified applause as Donaldson's Hospital; and his success there was all the more remarkable, because the style was altogether new to him. This has been described by one of his most successful ephemeral biographers,—plainly a zealous, yet impartial, and able admirer,—as a type of Gothic style; for which the author is obliged to admit, with evident compunction, the unhappy cognomen of "Debased Gothic." But let us call this work of Playfair's hands more fitly the "Inhabitable Gothic;" and no one has been more perfectly successful in making the Gothic habitable than our deceased fellow-member. No pleasure however is without alloy. There are few who will not regret that so magnificent a pile had not been destined for a more conformable object. Scotchmen were usually charged in former days by their neighbours with presenting, by a species of elective attraction, the frequent union of poverty and pride. It may be allowable in a native of the Scotch metropolis to lament, that the old sneer should be verified in these present times, by the pride of lodging poverty in such a palace.

I am assured that Playfair was so conscientiously fastidious in discharging the trust reposed in him as a professional man, that he executed all his drawings with his own hands. When engaged in this task, he for many years constantly worked in the standing posture, often for twelve hours a-day. To this habit he himself ascribed, not without justice, a paralytic affection of the spine, which gradually stole upon him when he was a man of middle life only. Slowly increasing year after year, it at last prevented in a great measure locomotion. But his aptitude for exercise of the mind continued unimpaired long afterwards. And even when his sad malady, spreading upwards, enfeebled his arms, and at length invaded also his mental faculties, it only required a new point in his plans to need consideration, when he was aroused to his old perspicuity and decision, and the point was settled.

Playfair was, in every good sense of the words, a scholar and a gentleman. As such, his society was courted on all hands. But for many years his infirmities had withdrawn him very much from the social circle; so that few except one or two old intimates can now tell how much society has lost in this respect by his death. He died in his sixty-eighth year. No one can doubt that his memory will long survive in his works.

The biography of *William Scoresby* belongs not so much to us as to the parent Society of the sister kingdom. But as this remarkable man frequently visited us, joined us as an Ordinary Fellow, sometimes contributed to the business of our meetings, and was in early life a student of our University during the winter intervals of repose from his voyages of Arctic adventure, it becomes me to advert shortly to the departure of one so eminent in Science, so amiable in disposition, so distinguished for Christian virtue.

Scoresby was the son of an experienced whaler and able navigator of Whitby, in Yorkshire. The father's zeal in his profession was so intense and catholic, that he actually carried off his child to his favourite Arctic regions at the age of ten, without the previous knowledge of Mrs Scoresby,—an attached wife, and no less fond a mother. The idea, it must be added, did not occur to the father till he one day detected, with much trouble, the urchin hidden below in the Resolution, while the "Blue Peter" was flying from the mast-head, and when the boy had a clear intention of running away from home in this remarkable manner. Entering thus early on a life of fearless adventure, it is no wonder that the second Scoresby outstripped the first in eminence as a navigator. At the age of sixteen, he discovered with his father an open sea near Spitzbergen, apparently stretching towards the North Pole; and he actually sailed in it to the latitude of 78° 46′,—the highest known to have been ever attained up to that time. At the age of twenty-one he succeeded his father as commander of the Resolution whaler of Whitby; and for twelve years afterwards he annually fished the Greenland Seas, carrying on at the same time constant researches in geography, magnetism, geology, and zoology; for which he had prepared himself by several winters of study under Jameson and other Professors of the University of Edinburgh. The results were published in his "Account of the Arctic Regions," and in his "Voyage to the Northern Whale Fishery."

A deep pure vein of piety, fostered by careful early training on the part of his parents, everywhere pervaded his pursuits, whether professional or scientific. No whale was hunted, and no other work that could be dispensed with was done, by the crew of the Resolution on the Sabbath. Their captain was constantly as assiduous in maintaining the religious condition of his men, as in preserving their health, and availing himself of their seamanship. But it is also recorded of him, that he generally contrived to reward the forbearance of his men while their game was sporting securely on all sides around them on Sunday, by ensuring that they should make prize of a whale or two at the first entrance of the hours upon Monday morning.

The depth and sincerity of his feelings, as a responsible creature, he has recorded in his "Sabbaths in the Arctic Regions." The ultimate consequence of his following this bent of his mind was, that, while still in the prime of life and vigour, he deserted his favourite the sea, studied at Cambridge for the English Church, took soon afterwards the degree of Doctor of Divinity, and became a zealous and efficient member of the ministry, first among his co-mates as Chaplain to the Mariner's Church at Liverpool, and eventually at Bradford, as pastor of an extensive manufacturing population.

The ardent and conscientious discharge of his religious duties, however, did not prevent him from applying also to the favourite scientific pursuits of his youth. Only a year before his death, indeed, he undertook a voyage to Australia, for the purpose of testing his theory respecting the aberration of the compass in iron ships ; and one of his last scientific observations was the measurement of the ocean wave in a storm off the Cape of Good Hope, when he ascertained that the elevation of the highest, when the sea "ran mountains high," was forty feet from trough to crest.

I cannot, consistently with the indispensable brevity of this sketch, even so much as enumerate Dr Scoresby's many contributions to science ; but must hasten at once to the close of this theme. Scoresby died, after a tedious illness, at a fair old age, in his 68th year. Few men can at that age console themselves with the retrospect of so long an existence so usefully spent. The intrepid seaman, the skilful navigator, the philosopher of no mean order, and the pious divine, was throughout his entire life full of good works in each and all of his multifarious vocations.

The connection of *Marshall Hall* with our Society has been somewhat similar to that of the Arctic Navigator. Born in Nottinghamshire, and trained there till his 19th year, he then came to this city in 1809 to pursue the study of medicine. He graduated at our University in 1812 ; remained two years longer as one of the resident physicians of the Royal Infirmary ; was elected during that period President of the Royal Medical Society, an office which has generally been the forerunner and presage of future distinction ; delivered, it seems, a short course of lectures on the Diagnosis of Diseases, ever afterwards a favourite subject of inquiry with him ; and on leaving this, to settle as a physician in Nottingham, continued to maintain his predilection for Edinburgh, as is shown by his having joined its Royal Society as a Fellow in 1819. But this has been the full amount of his connection with us.

He had been scarcely twelve years in Nottingham, when the promptings of genius induced him to seek a fitter field for its development in London, where he slowly attained a respectable place as a physician. His contributions to the practice of his profession, both before and after he settled in London, were numerous, always ingenious, often original, generally valuable, but sometimes controvertible. Of all these contributions none perhaps will convey a higher idea of his acute and inventive discrimination as a physician, than his inquiry, begun in 1824, and perfected some years afterwards, into the constitutional effects of the loss of blood, of which he successfully investigated the phenomena, supplied the explanation, and detailed the conclusions, in the shape of valuable instruction, for distinguishing between inflammation and nervous irritation, thereby laying down the means of escape from fearful errors at that time often committed by the incautious and uncompromising admirers of blood-letting as a remedy.

But the credit, which may be justly claimed for Marshall Hall for his contributions to medical experience and practice, sinks into insignificance when compared with his higher fame as a physiologist. It belongs properly to the sister Royal Society to sketch biographically the details of his discoveries in physiology. From me they can receive but a brief and passing notice, without too great a demand on your time and attention. I must confine myself, indeed, to only one of them, but that the greatest of all, the precursor and foundation of all the rest, and sufficient of itself to stamp Marshall Hall as an inventive genius, whose name will go down to posterity as one of the pillars of physiological science in the present century.

It is evident from his works that Marshall Hall's attention had been eagerly turned to the immortal discoveries of our greatest Scottish physiologist in these recent times, the late Sir Charles Bell, in regard to the functions of the brain, spinal marrow, and nerves. From that moment the nervous system was his great centre of attraction. Sir Charles first sighted, and laid down in an undeniable shape, the grand fact in the physiology of the nervous system, that sensation is conveyed and motion governed by different nerves, or different filaments of nerves, having different origins in the cerebro-spinal system. Hall, however, was the first to see that this separation of what were once conceived to be common functions of all, or almost all, nerves, was not enough to account for the whole phenomena of nervous action. He showed that, sensation being conveyed from the circumference to the centre, the brain, by one set of nerves, or filaments of nerves,—as Sir Charles first indicated,—and motion being excited by volition sending an influence from the centre to the circumference by means of other nerves or nervous filaments,—also a branch of Bell's discoveries,—there is another class of actions caused, independently of volition or of consciousness, by external impressions made directly on the spinal marrow itself; and, above all, that there is another set of numberless mysterious movements and actions, mysterious formerly,—but intelligible and clear as noon-day since his inquiries have been accepted,—which are excited by an agency, conveyed first from the circumference along *afferent* filaments of nerves to the spinal marrow as their centre, and thence along other or *efferent* nervous filaments to the circumference where action is eventually manifested, and all this independently of volition, often too of sensation, and not unfrequently of consciousness. These actions, which are constantly illustrated in the exercise of our functions, such as in the acts of breathing, swallowing, discharging the excretions, sneezing, coughing, winking, and the like, constitute what are called by Hall *Reflex Actions*. They are also exemplified by a thousand phenomena occurring during disease. Let me instance one example, which will at once render his discovery of Reflex Actions intelligible to any common understanding. When in poisoning with prussic acid, the sufferer is perfectly insensible and motionless, and no muscular action is discoverable except a spasmodic upturning of the eyeballs, and a slow, short, imperfect respiration,—if we pour upon the head suddenly a full stream of cold water, instantly a deep inspiration is drawn, which fills the whole chest. By repeating this process, we remove several of the immediate and sure causes of death, and may restore consciousness, sensibility, and at last perfect health. But this by the bye; the main purpose in quoting the fact now is to exemplify an action caused by an impression on a part of the nervous circumference, conveyed by certain nervous filaments to the spinal marrow, and transmitted instantly by certain other nervous filaments to the muscles which maintain respiration,—and quite independently of volition, of sensation, of consciousness, of all the cerebral functions in short, which, in the case supposed, are totally dormant and suspended. This is a reflex action, one of a countless multitude of phenomena which were entirely, or almost altogether, misunderstood until Marshall Hall caught the first glimpse of them, investigated, elucidated, and classified them, and deduced innumerable conclusions from them for explaining previously incomprehensible phenomena occurring in health, and still more in disease. This is the grand fact, the discovery of which we owe to Marshall Hall, and from which he afterwards proceeded to further discoveries in the physiology of the nervous system.

Like other discoverers, he at first encountered much opposition to his new views. But all physiologists and physicians are now agreed in adopting the most important of them, and in acknowledging the obligations which physiology and medical practice owe to him. For many of the latter years of his life, he was esteemed as one of the most successful physiological inquirers in Europe. He persevered in his researches till near the end of his life, which terminated in a slow and painful illness before the close of his 67th year.

It still remains for me to take notice of one other loss which the Society and science have sustained, and a loss which, to us in particular, is the most serious which the last twelve months have brought forth. By the death of *Dr John Fleming*, the Royal Society has lost not only a man well known to science, but likewise one of its most useful and active members. He may be said to have been the last survivor of a group of naturalists who gave lustre to Scotland soon after the commencement of the present century.

John Fleming was born at Bathgate in 1785. Having chosen the Church for his profession, and having been settled at an early age as a minister of the Church of Scotland, in the charge of the parish of Bressay, in Shetland, his first writings as a naturalist consisted of observations which he made on the zoology and geology of that interesting group of islands. Papers were read by him to the Wernerian Society of this city, so early as 1808, when he was only twenty-three years of age, on the Narwhal, and on the Rocks of Papa Stour. Being translated soon afterwards to the parish of Flisk, on the south shore of the Frith of Tay, he had fresh materials around him for pursuing his favourite researches, and made ample use of them for cultivating various branches of Natural History. Several of the most interesting districts of his neighbourhood, such as St

Andrews and the Red Head, were first geologically described by Fleming.

Gradually, however, his attention during the hours he could spare from his professional duties became concentrated in the study of animals; and the results appeared in 1822 in his "Philosophy of Zoology," a laborious and still most serviceable work, which instantly obtained for him a high reputation as a philosophical naturalist. This was followed by another work of equal labour, "On British Animals," in which he exhibited their descriptive characters. Fleming also contributed to the *Encyclopædia Britannica* some important papers on sections of the Animal Kingdom, particularly one on the Mollusca.

Throughout these and all his other labours as a man of science, our departed associate never ceased to sustain his earnest and conscientious character as a minister of the Gospel. It is stated of him that, on being translated in 1832, from comparatively light duty at Flisk to the parish of Clackmannan, where he had pastoral charge of a populous flock, he deliberately locked up his cabinets, until familiarity with his duties should enable him to open them at a more convenient season.

In 1834 he was relieved altogether from his labours as a minister of the Word, by accepting the chair of Natural Philosophy in King's College, Aberdeen. It is to be regretted that a more congenial position in a University did not at this time open to him; for, in a chair of Natural History, he could not have failed to confer lustre both upon himself and upon his University; whereas, in a chair of Physics, entered on not till the 45th year of his age, he never could have risen beyond the level of a diligent teacher. At length a more suitable position was attained by him in 1845, when he undertook the Professorship of Natural Science in the Free Church College of Edinburgh. Here his object more especially was to give the future pastors of the Free Church a general acquaintance with Natural Science, so as to prepare them in some measure for the discussion of the various questions on which it is now so frequently brought in contact with religion. It is generally acknowledged, that in this field of exertion, Dr Fleming proved of the greatest utility to the communion of which he was the ornament. He had that object always much at heart, and when assured that his chair would probably be maintained in perpetuity, he declared that he felt as if a kind of dew had fallen upon him, invigorating his aged frame to increased activity.

Notwithstanding the comprehensive nature of his "Philosophy of Zoology," it will probably be generally admitted, that Dr Fleming's great merit as a man of science lay in his careful and vigilant power of observation. His knowledge of rocks, of fossils, and of living species, was no less extensive than exact. It was perhaps in some measure his profound and ever active sense of what was necessary for the faithful observation of a fact, which made him distrustful beyond rule of what was reported by others. Caution, carried to such a degree as to amount to a scientific scepticism in receiving the testimony of others, exercises eventually a baneful influence on the fruits of the mind that thus indulges in it; for the benefit is thereby lost of much that has been tolerably well ascertained by other inquirers, and conclusions are apt to be pertinaciously opposed long after the world of science has generally considered them as settled. It may be doubted whether Dr Fleming did not sometimes incur this misfortune. Yet, while he was engaged in disputing evidence and battling off inductions, even those who might think him unreasonable were forced to acknowledge, and even to admire, his extraordinary shrewdness, and the philosophic caution by which he was prompted in every movement of his own mind.

It is understood that Dr Fleming had prepared a new work on the Geology of the Environs of Edinburgh, a subject always of deep interest, and on which few men were so well entitled to speak. Of this work it is gratifying to learn that a large portion has already been put through the press.

For this short sketch of his scientific life, I am principally indebted to our fellow-member, Mr Chambers. For some months at least before his death, Dr Fleming had been observed by his friends to fail in looks and strength, owing to some obscure disturbance of the digestive organs. At last, and when no apprehensions were entertained of so sudden a termination to his life of usefulness, he was seized abruptly with violent illness, which proved to be owing to perforation of the stomach, and which ended fatally next morning, only fifteen days ago.

With this imperfect tribute to his memory, I bring to a conclusion what may be fairly stated from this chair regarding one whose communications to our meetings were numerous, singularly lucid, and always received with marked attention; whose criticisms invariably restored animation when our interest threatened to flag; and whose strictures, if they sometimes cut rather deep, never failed to strike out new ideas from any adversary who was worthy of his lance. It is in these capacities that we who are now here assembled will long fondly recall him, and lament his removal from our circle, and feel that it will be hard to supply his place.

The following Communication was read :—

Excursions in the Troad, with observations on its Topography and Antiquities. Part I. By Dr William Robertson, F.R.C.P. Communicated by Dr J. Y. Simpson.

The following Candidates were elected Ordinary Fellows :—

Dr Williamson, of Leith, F.R.C.S. Ed.
Dr Malcolm, F.R.C.P. Ed.
Dr James Duncan, F.R.C.S. Eng. and Ed.

The following Donations to the Library were announced :—

Scheikundige Verhandelingen en Onderzoekingen door G. J. Mulder. Eerste Deele. Rotterdam, 1857. 8vo.—*From the Dutch Government.*

List of Members of the Institute of Actuaries. 8vo.—*From the Institute.*

Letter to Lord Viscount Palmerston on Medical Reform. By John G. M. Burt. Edinburgh, 1857. 8vo.—*From the Author.*

Collection of Admiralty Charts, and relative Lists, and other Documents. *From the Lords of Admiralty.*

Proceedings of the Berwickshire Naturalists' Club. Vol. iv., Part 1. 8vo.—*From the Club.*

Notices of the Meetings of the Members of the Royal Institution of Great Britain. Part 7. 8vo.—*From the Society.*

Transactions of the Historic Society of Lancashire and Cheshire. Vol. ix. London, 1857. 8vo.

Charts of Track-Survey of the Rivers Salado, Parana, and Colastiné. By Commander Thomas J. Page, U.S.S. Water Witch. 1855. —*From the Author.*

Annalen der Königlichen Sternwarte bei Münich. Band ix. 8vo.—*From the Observatory.*

Fortschritte der Physik. Jahr 1847, zweite abtheilung; 1853; 1854. Berlin. 8vo.—*From the Physical Society, Berlin.*

Proceedings of the Royal Astronomical Society. Vol. xvii., No. 9. 8vo.—*From the Society.*

Resultate aus den an der Königl. Sternwarte veranstalteten meteorologischen Untersuchungen, nebst Andentungen über den Einfluss des Clima von München auf die Gesundheits-Verhältnisse der Bewohner. Von Dr J. Lamont. München, 1857. 4to.—*From the Observatory.*

Catalogue of the New York State Library. 2 vols. Albany, 1856. 8vo.—*From the State.*

Documents relative to the Colonial History of the State of New York, procured in Holland, England, and France, by John Romeyn Brodhead. Edited by E. B. O'Callaghan, M.D. Vols. v., vi., and ix. Albany, 1855. 4to.—*From the American Geographical and Statistical Society.*

Proceedings of the Academy of Natural Sciences of Philadelphia for 1856–7. 8vo.—*From the Academy.*

Proceedings of the American Philosophical Society. Vol. vi., No. 56. 8vo.—*From the Society.*

Transactions of the American Philosophical Society. New Series. Vol. ii., Part 1. Philadelphia, 1857. 4to.—*From the Society.*

Reports of the Commissioners of Patents for 1855. 8vo.—*From the American Geographical and Statistical Society.*

First Annual Report on the Improvement of the Central Park, New York. New York, 1857. 8vo.—*From the same Society.*

Memoirs of the American Academy of Arts and Sciences. New Series. Vol. vi., Part 1. Cambridge and Boston, 1857. 4to.—*From the Society.*

Smithsonian Contributions to Knowledge. Vol. ix. Washington, 1857. 4to.—*From the Smithsonian Institution.*

Report on Insanity and Idiocy in Massachusetts. By the Commission of Lunacy. Boston, 1855. 8vo.—*From the American Statistical Society.*

Report of the Superintendent of the Coast Survey, showing the progress of the Survey during the year 1855. Washington, 1856. 4to.—*From Professor Bache.*

Quarterly Return of the Births, Deaths, and Marriages registered in the Divisions, Counties, and Districts of Scotland. Quarters ending 31st March 1857, 30th June 1857, and 30th September 1857. 8vo.—*From the Registrar-General.*

Calcul Decidouzinal par M. le Baron Silvio Ferrari; traduction sur l'original Italien. Turin, 1857. 4to.—*From the Author.*

Magnetische Ortsbestimmungen ausgeführt an verschiedenen Puncten des Königreichs Bayern und an einigen auswärtigen Stationen. Von Dr J. Lamont. 2 Theil. Munchen, 1856. 8vo.—*From the Author.*

Specimen of Tables, calculated and stereomoulded by the Swedish Calculating Machine of George and Edward Scheutz. London, 1857. 8vo.—*From the Authors.*

Report of Council read at the Annual General Meeting, held 4th May 1857, of the Royal Institute of British Architects. 4to, —*From the Institute.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt. Nos. 2, 3. Wien, 1856.—*From the Institute.*

Quarterly Journal of Agriculture and Transactions of the Highland and Agricultural Society of Scotland. July and October 1857. —*From the Society.*

Transactions of the Linnean Society of London. Vol. xxii. Part 1. London, 1856. 4to.—*From the Society.*

American Journal of Science and Arts, conducted by Professors Silliman and Dana. May and September 1857.—*From the Editors.*

Resumen de Los Trabajos Meteorologicos correspondientes al año 1854, verificados en el Real Observatorio de Madrid bajo la direccion de D. Manuel Rico y Sinobas. Madrid, 1857. 4to.—*From the Observatory.*

Comte-Rendu Annuel adresse a s. exc. M. De Brock, Ministre des Finances, par le Directeur do l'Observatoire Physique Central, A. T. Kuppfer. Annee 1855. St Petersburg, 1856. 4to.—*From the Observatory.*

Assurance Magazine and Journal of the Institute of Actuaries. July and October 1857. 8vo.—*From the Institute.*

Descriptions of four new species of Unios, &c. By Isaac Lea, LL.D. Philadelphia, 1857. 8vo.—*From the Author.*

Report of the Secretary of War, communicating Colonel Graham's Report of the Harbours, &c., in Wisconsin, Illinois, Indiana, and Michigan. Washington, 1856. 8vo.—*From the Secretary of War, U.S.*

Statistical Report on the Sickness and Mortality in the Army of the United States, compiled from the Records of the Surgeon General's Office; embracing a period of sixteen years, from January 1839 to January 1855. By Richard H. Coolidge, M.D. Washington, 1856. 4to.—*From the Surgeon-General, U.S. Army.*

Astronomische Beobachtungen auf der Königlichen Univeristäts Sternwarte zu Königsberg. Sieben und zwanzigste, acht und zwanzigste und dreissigste Abtheil. Königsberg, 1856. 8vo.—*From the Observatory.*

Verslagen en Mededeelingen der Koninklijke Akademie van Wetenschappen. Afdeeling Natuurkunde, vijfde Deel, tweede und derde Stuk; zesde deel, eerst, tweede, und derde Stuk. Afdeeling Letterkunde, tweede Deel, tweede, derde, und vierde Stuk. Amsterdam, 1856–57. 8vo.—*From the Academy.*

Octaviæ Querela. Carmen cujus auctori Johanni van Leeuwen, e Vico Zegwaart, certaminis poetici præmium secundum e legato Jacobi Henrici Hoeufft adjudicatum est in consessu publico Academiæ Regiæ Scientiarum, die 9m. Martii anni 1857. Amstelodami, 1857. 8vo.—*From the Academy.*

Report of the Geological Survey in Kentucky, made during the years 1854 and 1855. By David Dale Owen. Frankfort, Kentucky, 1856. 8vo.—*From the Smithsonian Institution.*

Report of the Commissioners of Patents for the year 1855. Agriculture, Arts, and Manufactures. Washington, U.S., 1856. 8vo.—*From the U.S. Patent Office.*

Report of the Secretary of State on the Criminal Statistics of the State of New York. Albany, 1855. 8vo.—*From the State.*

Annual Report of the Commissioners of Emigration of the State of New York, for the year ending 31st December 1856. New York, 1856. 8vo.—*From the State.*

Annual Report of the Canal Commissioners of the State of New York, for 1854. Albany, 1855. 8vo.—*From the State.*

Report of the Joint Special Committees of the Chamber of Commerce, and American Geographical and Statistical Society, on the extension of the decimal system to Weights and Measures of the United States. New York, 1857.—*From the American Statistical Society.*

Annual Report of the Secretary of State, relative to Statistics of the Poor of New York. Albany, 1855. 8vo.—*From the State.*

On the Statistics and Geography of the Production of Iron. By Abram S. Hewitt. New York, 1856. 8vo.—*From the American Geographical and Statistical Society.*

Report of the State Engineer and Surveyor on the Canals of the State of New York, for 1854. Albany, 1855. 8vo.—*From the State.*

Bulletin of the American Geographical and Statistical Society. Vol. ii. New York, 1857. 8vo.—*From the Society.*

The Growth of Cities. By Henry P. Tappan, D.D. New York, 1855. 8vo.—*From the New York Geographical Society.*

Eighth Annual Report of the Governors of the Alms House, New York, for the year 1856. New York, 1857. 8vo.—*From the Governors.*

Access to an open Polar Sea, in connection with the search after Sir John Franklin, and his Companions. By E. K. Kane, M.D. New York, 1853. 8vo.—*From the American Geographical and Statistical Society.*

Annual Report of the Board of Regents of the Smithsonian Institution, for the year 1856. Washington, 1857. 8vo.—*From the Institution.*

An Account of the Smithsonian Institution, its Founder, Building, Operations, &c. By William J. Rhees. Washington, 1857. 8vo.—*From the Smithsonian Institution.*

The Transactions of the Academy of Science of St Louis. Vol. i. St Louis, 1857. 8vo.—*From the Academy.*

Annual Reports of the Board of Agriculture of the State of Ohio, for the years 1850, 1851, 1852, 1853, 1855. 8vo.—*From the State of Ohio.*

On the New Red Sandstone Formation of Pennsylvania, &c. By Isaac Lea, LL.D. Philadelphia, 1856. 8vo.—*From the Author.*

Archæologia; or, Miscellaneous Tracts, relating to Antiquity, published by the Society of Antiquaries, London. Vol. xxxvi.

Part 2, and Vol. xxxvii., Part 1. London, 1857, 4to.—*From the Society.*

Proceedings of the Boston Society of Natural History. 1856–7. 8vo.—*From the Society.*

Nova Acta Regiæ Societatis Scientiarum Upsalensis. Seriei tertiæ, Vol. i. Fasc. 1 et 2; Vol. ii., Fasc. 1. Upsal 1855–6. 4to. —*From the Society.*

Mémoires Couronnés et Mémoires des Savants Étrangers, publies par l'Académie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique. Tomes xxvi., xxvii., xxviii. Bruxelles, 1855–6. 4to.—*From the Academy.*

Mémoires de l'Académie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique. Tome xxx. Bruxelles, 1857. 4to.—*From the Academy.*

Nouveaux Mémoires de la Société Impériale des Naturalistes de Moscou. Tome x. Moscou, 1855. 4to.—*From the Society.*

Astronomical Observations made at the Royal Observatory, Edinburgh. By Charles Piazzi Smyth, F.R.SS.L. and E. Vol. xi. for 1849–54. Edinburgh, 1857. 4to.—*From the Observatory.*

Report on the Adjudication of the Copley, Rumford, and Royal Medals; and appointment of the Bakerian, Croonian, and Fairchild Lectures, compiled from the original Documents in the Archives of the Royal Society. By James Hudson. London, 1834. 4to.—*From the Society.*

Six Discourses delivered before the Royal Society at their Anniversary Meetings, on the award of the Royal and Copley Medals; preceded by an Address to the Society on the progress and prospects of Science, by Sir Humphry Davy, Bart. London, 1827. 4to.—*From the Society.*

Mémoires de l'Académie Impériale des Sciences de St Petersburg. Sixieme Serie. Sciences Naturelles, Tome vii.; Sciences Politiques, Histoire, Philologie, Tome viii. St Petersbourg, 1855. 4to.—*From the Academy.*

Mémoires Présentés a l'Académie Impériale des Sciences de St Petersbourg par divers Savants et lus dans ses Assemblees. Tome vii. St Petersbourg, 1854. 4to.

Annuaire de l'Académie Royale des Sciences, des Lettres, et des

Beaux-Arts de Belgique, 1856, 1857. Bruxelles, 12mo.—*From the Academy.*

Almanach der Kaiserlichen Akademie der Wissenschaften. Siebenter Jahrgang, 1857. Wien. 8vo.—*From the Vienna Academy.*

Astronomical and Meteorological Observations made at the Radcliffe Observatory, Oxford, in the year 1855, under the superintendence of Manuel J. Johnston, M.A., Radcliffe Observer. Vol. xvi. Oxford, 1856. 8vo.—*From the Observatory.*

Journal of the Asiatic Society, 1856, No. 6; 1857, Nos. 1, 2, and 3. Calcutta. 8vo.—*From the Society.*

Étioles Filantes. Télégraphe Électrique. Phénomènes periodique. Par A. Quetelet. 8vo.—*From the Author.*

Rapport adressé a M. le Ministre de l'Interieur, sur l'Etat et les Travaux de l'Observatoire Royale, pendant l'année 1856; par le Directeur A. Quetelet.—*From the Author.*

Proceedings of the Royal Astronomical Society. Vol. xvii., Nos. 4–7.—*From the Society.*

Des Observatoires du Nord de l'Allemagne et de la Hollande et du Magnétisme Terrestre dans ces deux Contrees. Par Ernest Quetelet. 8vo.—*From the Author.*

Rapport de M. Ad. Quetelet sur une Memoire concernant l'etat actuel des lignes isoclimiques et isodynamiques dans la Grande Bretagne, la Hollande, la Belgique et la France, d'après les Observations de l'auteur M. Mahmoud-Effendi, Astronome Egyptien. 8vo.—*From M. Quetelet.*

Proceedings of the Society of Antiquaries of London. Vol. iii., Nos. 43–46. London. 8vo.—*From the Society.*

List of the Society of Antiquaries of London, 1856. 8vo.—*From the Society.*

Journal of the Geological Society of Dublin. Vol. vii., Part 4, Dublin, 1857. 8vo.—*From the Society.*

Bulletin de la Société Impériale des Naturalistes de Moscou. Annee 1853, Nos. 3, 4; 1855, Nos. 2, 3, et 4; 1856, No. 1. Moscou. 8vo.—*From the Society.*

Extrait du Programme de la Société Hollandaise des Sciences à Harlem, pour l'annee 1857. 4to.—*From the Society.*

Monthly Returns of the Births, Deaths, and Marriages registered in the eight principal Towns of Scotland. March, April, May, June, July, Sept, 1854. 8vo.—*From the Registrar-General.*

Memoirs of the Geological Survey of India. Calcutta, 1856. 8vo. —*From the Governor-General of India.*

Journal of the Royal Geographical Society. Vol. xxvi. London, 1856. 8vo.—*From the Society.*

Flora Batava. 181 aflevering. 4to.—*From the King of Holland.*

Método lexiologica y hermeneutico para aprender la lengua francesa fundado en las leyes de entomologia, analogia, y onomatopeya, que presiden à la formacion de las Lenguas. Par Don Vicente Alcober y Largo. Madrid, 1857. 4to. —*From the Author.*

Quarterly Journal of the Chemical Society. No. 37. 8vo.—*From the Society.*

Nouveaux Mémoire sur la Question relative aux Ægilops triticoides et speltiformis. Paris, 1857. 8vo.

Archives du Museum d'Histoire Naturelle publiées par les Professeurs-Administrateurs de cet Etablissement. Tome ix. Paris, 1856. 4to.—*From the Museum.*

Bulletin de la Société des Sciences Naturelles de Neuchatel. Tome iv., premier cahier. Neuchatel, 1856. 8vo.—*From the Society.*

Transactions of the Architectural Institute of Scotland. Vol. v. (Session 1855–6). Edinburgh, 1856. 8vo.—*From the Society.*

Astronomical, and Magnetical, and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1855, under the direction of George Biddell Airy, M.A., Astronomer-Royal. London, 1857. 4to.—*From the Board of Admiralty.*

Tables de la Lune construites d'après de principe Newtonien de la gravitation universelle, par P. A. Hansen, Directeur de l'Observatoire Ducal de Gotha. Imprime aux frais du Gouvernement Britannique. Londres, 1857. 4to.—*From the Board of Admiralty.*

Ophthalmic Hospital Reports and Journal of the Royal London Ophthalmic Hospital. Edited by J. F. Streatfield. No. 1, October 1857. London, 8vo.—*From the Editor.*

Magnetical and Meteorological Observations made at the Hon. East India Company's Observatory, Bombay, under the superintendence of Lieutenant E. F. T. Ferguson, I.N. For years 1854-5. Bombay, 1855-6. 4to.—*From the Hon. E. I. Company.*

Catalogue of the Library of the Philosophical Institution of Edinburgh. Edinburgh, 1857. 8vo.—*From the Institution.*

Jahresbericht über die Fortschritte der reinen, pharmaceutischen und technischen Chemie, Physik, Mineralogie und Geologie. Unter Mitwirkung von H. Buff, F. Knapp, H. Will, F. Zamminer, herausgegeben von Justus Liebig und Hermann Kopp. Für 1856. Giessen, 1857. 8vo.—*From the Editors.*

Journal of the Proceedings of the Linnean Society. Vol. ii., Nos. 5 and 6. London, 1857. 8vo.—*From the Society.*

Bulletin de la Société des Sciences Naturelles de Neuchatel. Tome iv., deuxième cahier. Neuchatel, 1857. 8vo.—*From the Society.*

Proceedings of the Royal Geographical Society of London, No. 8. London, 1857. 8vo.—*From the Society.*

Address delivered at the Anniversary Meeting of the Geological Society of London, on 20th February 1857, by Colonel J. E. Portlock, R.E., President of the Society. London, 1857. 8vo. —*From the Author.*

A new Classified Catalogue of the Library of the Royal Institution of Great Britain, with indexes of Authors and subjects, and a list of historical Pamphlets chronologically arranged. By Benjamin Vincent. London, 1857. 8vo.—*From the Institution.*

Die Bohmischen Exulanten in Sachsen. Von Christian Adolph Pescheck. Leipzig, 1857. 8vo.—*From the Author.*

Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin. 1855, 1856. Berlin, 4to.

Transactions of the Zoological Society of London. Vol. iv., Part 4. London, 1857. 4to.

Twenty-fourth Annual Report of the Royal Cornwall Polytechnic Society, 1856. Falmouth. 8vo.

Proceedings of the Zoological Society. Nos. 310-338. London. 8vo.

The Bakerian Lecture. Experimental Relations of Gold (and other Metals) to light. By Michael Faraday, D.C.L. London, 1857. 4to.—*From the Author.*

Sur le Climat de la Belgique. De l'Etat du Ciel en général, par A. Quetelet. Bruxelles, 1857. 4to.—*From the Author.*

Annales de l'Observatoire Royal de Bruxelles, publieés, aux frais de l'Etat, par le Directeur, A. Quetelet. Tome xi. Bruxelles, 1857. 4to.—*From the Observatory.*

Observations des Phénomènes Périodiques. Bruxelles. 4to.—*From M. Quetelet.*

Contributions to the Meteorology and Hydrography of the Indian Ocean. By Charles Meldrum, A.M. Part 1. Mauritius, 1856. 4to.—*From the Author.*

Monatsbericht der Königlichen Preuss. Akademie der Wissenschaften zu Berlin. Januar – August 1857.—*From the Berlin Academy.*

Denkschriften der Kaiserlichen Akademie der Wissenschaften. Mathematisch - Naturwissenschaftliche Classe, Zwolfter Band. Vienna, 1856. 4to.—*From the Academy.*

The Quarterly Journal of the Geological Society. Vol. xiii. Parts 2 and 4. London, 1857. 8vo.—*From the Society.*

Ueber die Placodermen des Devonischen Systems. Von Dr Christian Heinrich Pander. St Petersburg, 1857. 4to.—*From the Corps des Ingénieurs des Mines de Russie.*

Monographie der Fossilen Fische des Silurischen Systems der Russisch-Baltischen Gouvernements. Von Dr Christian Heinrich Pander. St Petersburg, 1856. 4to.—*From the Corps des Ingénieurs des Mines de Russie.*

Bulletin de la Société Impériale des Naturalistes de Moscou. Tome xxvii., No. 1. Moscou, 1854. 8vo.—*From the Society.*

The Canadian Journal of Industry, Science, and Art, conducted by the Canadian Institute. New Series, Nos. 8 and 10, July–September 1857. Toronto. 8vo.—*From the Society.*

Bulletins de l'Académie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique. Tome xxii. 2^{ieme} partie; Tome xxiii. Bruxelles, 1855-6. 8vo.—*From the Academy.*

Journal of the Statistical Society of London. Vol. xxii., Part 2. (June 1857). London. 8vo.—*From the Society.*

Compte Rendu de l'Académie Impériale des Sciences de St Petersbourg. 1852, 1853, 1854, 1855. St Petersbourg. 8vo.—*From the Academy.*

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Mathematisch - Naturwissenschaftliche Classe, Band xxii.; Band xxiii., Heft 1. Philosophisch-Historische Classe, Band xxi., Heft 3; Band xxii., Heft 1 und 2. Vienna, 1856-7. 8vo.—*From the Imperial Academy, Vienna.*

Annuaire de l'Observatoire Royal de Bruxelles, par A. Quetelet, 1856, 1857. Bruxelles. 12mo.—*From the Author.*

Berichte über die Verhandlungen der Königlich Sächsischen Gesellschaft der Wissenschaften zu Leipzig. Mathematisch-Physische Classe, 1856, No. 2; 1857, No. 1. Leipzig. 8vo.—*From the Royal Saxon Society.*

Abhandlungen der K. S. Gesellschaft der Wissenschaften zu Leipzig. Mathematisch-Physische Classe, 1857. Leipzig. 8vo.—*From the same Society.*

Proceedings of the Literary and Philosophical Society of Liverpool, Session 1856-7. Liverpool, 1857. 8vo.—*From the Society.*

Memorias de la Real Academia de Ciencias de Madrid, Tomo iv. Madrid, 1857. 4to.—*From the Academy.*

Judicial Statistics, Part 1, England and Wales. Police Criminal Proceedings.—Prisons. Returns for the year 1856.—*From the Secretary of State.*

Proceedings of the Royal Society of London. Vol. viii., Nos. 26 and 27. London, 1857. 8vo.—*From the Society.*

Memoire della Reale Accademia delle Scienze di Napoli. Vol. i., Fasc. 1, 2. 4to.—*From the Academy.*

Rendiconto della Societa Reale Borbonica. Napoli, 1856. 4to.—*From the Society.*

Quarterly Journal of the Chemical Society. July 1857. London. 8vo.—*From the Society.*

Journal of the Statistical Society of London. Vol. xx., Part 3. London, 1857. 8vo.—*From the Society.*

List of Fellows of the Statistical Society of London. 8vo.—*From the Society.*

Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger og dets Medlemmers Arbeider i Aaret 1856. Kjobenhavn, 1856. 8vo.—*From the Society.*

Biographical notice of the late Thomas Thomson, M.D. 1857. 8vo.—*From the Author.*

Address at the Anniversary Meeting of the Royal Geographical

Society, 25th May 1857. By Sir Roderick I. Murchison, President. London, 1857. 8vo.—*From the Society.*

M. le Baron Cauchy: Lettre de M. Biot a M. de Falloux. Paris, 1857. 8vo.—*From E. Cauchy.*

Silliman's American Journal of Science and Arts. July 1857. 8vo.—*From the Editors.*

Monthly Notices of the Royal Astronomical Society. Vol. xvi. London, 1856. 8vo.—*From the Society.*

Memoirs of the Royal Astronomical Society. Vol. xxv. London, 1857. 4to.—*From the Society.*

Philosophical Transactions of the Royal Society of London, for the year 1856. Vol. cxlvi., Part 3; do. for 1857, Vol. cxlvii., Part 1. London. 4to.—*From the Society.*

Memoire della Reale Accademia della Scienze de Torino. Serie Seconda, Tomo xvi. Torino, 1857. 4to.—*From the Academy.*

Kongliga Svenska Vetenskaps-Akademiens Handlingar ny foljd. Första Bandet, första häftet. Stockholm, 1855. 4to.—*From the Royal Academy of Sciences, Stockholm.*

Exposition des Operations faites en Lappoine pour la determination d'un arc du méridien. Stockholm, 1805. 8vo.—*From the same Academy.*

Ofversigt af Kongl. Vetenskaps-Akademiens Forhandlingar, för år 1856. 8vo.—*From the same Academy.*

Kongl. Vetenskaps-Akademiens Handlingar, för är 1854. 8vo.—*From the same Academy.*

Berättelse om Framstegen i Insekternas, Myriapodernas och Arachnidernas Natural Historia för 1853 och 1854, till Kongl. Vetenskaps-Akademien afgifven af C. H. Boheman. Stockholm, 1857. 8vo.—*From the same Academy.*

Arsberättelse om Botaniska Arbeten och Upptäckter under åren 1852, 1853, och 1854, (2 Bandet.) Till Vetenskaps-Akademien afgifven af J. Em. Wilkström och N. J. Andersson. 8vo.—*From the same Academy.*

Om förflutna tiders svenska Ordboksföretag, Tal i K. Vetens. Akademiens vid Præsidii nedläggande den 9 April 1856 af Bernh. v. Beskow. Stockholm, 1857. 8vo.—*From the same Academy.*

Bulletin de la Société de Geographie. Quatrieme serie, Tome xiii. Paris, 1857. 8vo.—*From the Society.*

Brief Extract from Memoranda of the Earl of Dundonald, on the use, properties, and products of the Bitumen and Petroleum of Trinidad. London, 1857. Folio.—*From Lord Dundonald.*

The U. S. Naval Astronomical Expedition to the Southern Hemisphere during the years 1849–50, 1851–52. Vol. vi., Magnetical and Meteorological Observations, under the direction of Lieut. J. M. Gilliss, LL.D., Superintendent. Washington, 1856. 4to.—*From Dr Gilliss.*

The following List of Donations, announced at the Society's Meeting on 2d March 1857, was omitted in its proper place in the Proceedings:—

Philosophical Transactions of the Royal Society of London. Vol. cxliv., Part 2, cxlv., and cxlvi. London, 1854–56. 4to.—*From the Society.*

Proceedings of the Royal Society, Vol. viii., No. 24.—*From the Society.*

Annales de l'Observatoire Physique Central de Russie. No. 2. Correspondance Météorologique pour l'anne 1854. St Petersbourg, 1855. 4to.—*From the Observatory.*

Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland. March 1857. Edinburgh. 8vo.—*From the Society.*

The American Journal of Science and Arts. January 1857. 8vo.—*From the Editors.*

Bulletin de la Société de Geographie, Quatrieme serie, Tome xii. 1857. 8vo.—*From the Society.*

Transactions of the Royal Scottish Society of Arts. Vol. iv., Part 4.—*From the Society.*

Natuurkundige Verhandelingen van de Hollandsche Maatschappij der Wetenschappen te Haarlem. Deel xii., tweede verzameling.—*From the Society.*

On certain Trains of Erratic Rocks on the Western borders of Massachusetts, U.S. By Sir Charles Lyell, F.R.S. 8vo.—*From the Author.*

Monday, 21*st December* 1857.

Professor Kelland, V.P., read from the Chair the following short Biographical Notices of MM. Thénard and Cauchy, two recently deceased Foreign Members of the Society.

In Dr Christison's excellent address at the last meeting, he presented you with biographical sketches of the recently deceased Home Members of this Society. I have been requested to complete his work, by adding a brief sketch of the lives of the two Foreign Members whom we have lost during the past session.

1. *M. Thénard.*—For the information which I have acquired relative to this excellent chemist, I am indebted to Dr Christison, who has furnished me with his personal recollections, and with a biographical souvenir of the deceased by one of his former assistants, M. Le Canu.

The association of the name of Thénard with the progress of Chemistry dates back to the period of history. His first contribution to the science was made so early as the year 1799; the subject being "The Oxygenated Compounds of Antimony, and their Combinations with Sulphuretted Hydrogen." His last was presented in 1856, fifty-seven years later, and is entitled "Memoir on the Bodies whose Decomposition is effected under the influence of the Catalytic Force." To detail all the discoveries of an author whose writings are scattered over so vast a period would be a work of some labour, and might justly be regarded by many of my hearers as a dry and unnecessary detail. A few of the more important only can be noticed.

We owe to him the production of muriatic ether. It is true, however, that Boullay in France, and Gehlen in Germany, made the discovery about the same time with himself. We owe to him also the discovery of oxygenated water, or the binoxide of hydrogen, and consequently that of the peroxide of calcium, of copper, &c., which it produces by reacting on the inferior oxides of these metals. M. Le Canu admits, in reference to this discovery, that a happy accident exhibited to M. Thénard the dissolution of binoxide of barium in water acidulated with nitric acid, without the disengagement of oxygen; but he argues very justly that the merit consisted in the far-seeing power which could divine the existence of a definite combination of oxygen and hydrogen, essentially distinct from ordinary water.

M. Thénard had the good fortune to labour in conjunction with a host of great men—with Fourcroy, with Dulong, with Biot, with Dupuytren, but, above all, with Gay-Lussac. It is in this last connection, I imagine, that his name comes most frequently under the eye of non-chemical readers amongst us. Gay-Lussac and Thénard published, in conjunction, a series of most valuable memoirs, which were afterwards united in two volumes. Of these volumes Berthollet thus speaks: "They seem to constitute a new science, raised on the old sciences of physics and chemistry as their groundwork." Amongst the vast mass of discoveries which these researches make known, I have space to mention only two: 1. A highly important series of facts tending to throw light on the relation between the chemical and the electrical energy of the voltaic pile. For example, that acidulated water, as compared with pure water, increases the chemical action of the pile, but diminishes the electrical; and that those fluids which were found most efficient in exciting the chemical powers of the battery are the most rapidly decomposed when subjected themselves to its action. 2. The indication of the means of obtaining considerable quantities of potassium and sodium, by subjecting caustic potash and soda to the contact of iron at a high temperature; and the train of consequences which flowed from the facility of producing those metals. The Memoir which contains the process referred to appeared in the *Moniteur* of the 15th and 16th November 1808. In it was announced the existence of a particular radical, boron, which Davy described a month later in a valuable paper read to the Royal Society of London.

Not the least important, however, of M. Thénard's publications was his *Traité de Chimie*, which has gone through six editions. He had a happy talent for popularizing, without the sacrifice of strict scientific accuracy. His genius lay in arranging the parts, in developing truths in succession, in bringing out the characteristic facts, and causing the whole science to rest symmetrically on them. And the same power of popularizing and arranging was observable in his lectures. The courses which he delivered at the Athenæum, at the

Faculty of Medicine, at the *Ecole Polytechnique*, at the College of France, were admirable of their kind. Notwithstanding his intimate acquaintance with the subject, and his long experience as a lecturer, he never presented himself before an audience, without having carefully planned the lecture, and determined the exact order and position which every part should occupy. He used to say that each fact had its own proper place, where alone it could be exhibited in relief, and that it was the duty of the Professor to determine this place beforehand, just as much as it is the duty of an author to clear his sentences of feeble tautology, and to attach the right word to every idea. In consequence of this care, his lecture was always complete, always a continuous lesson on the subject in hand; free alike from deficiency and from exuberance.

It is indeed in his character as a lecturer, that M. Thénard is best studied. On the public platform, the peculiar idiosyncracies of the whole man came out spontaneously. Let me endeavour to present him to you, as he stands before his class. Imagine a vast amphitheatre capable of holding a thousand persons—every seat occupied—the very lobbies and passages crowded to overflowing. At the back of the contracted space allotted to the Professor and his apparatus, stands a huge black board, well covered with chemical formulæ. The assistant whose duty it has been to prepare the experiments, stands anxiously regarding his work. The lecturer enters. Your ideas, derived from Hogarth, have perhaps pictured to you a thin spare man with a hatchet face, and you start when your eyes rest on a figure placed in strong relief against the black board, whose firm build and massive countenance more than come up to the typical John Bull of your own land. His broad full eye, set off by a dark mass of hair, first glances at the apparatus, then rises and haughtily scans the audience, as if to measure their capacity, and finally drops on the assistant, who quails beneath its weight. The lecture begins. So clear, so forcible, so continuous, is the stream which flows from the speaker's lips—so appropriate, so neat and so well performed are the experiments, that the hour passes over quickly and insensibly. But should any accident happen; should the unfortunate assistant have mistaken his directions; woe betide him. The presence of a thousand persons places no restraint on the lecturer's indignation. On one occasion, when he had given way to an unusually violent outburst, an illustrious hearer, said to be Baron Humboldt, thought it his duty to interfere, and request the master to have a little more patience with his assistant. The request was granted, and all went smoothly during the remainder of the lecture. For two days sunshine continued. On the third day M. Thénard, on entering the room, perceived a portion of the apparatus in a condition which foretold the failure of the experiment. Placing himself right in front of the benevolent stranger, and looking him full in the face, with his finger pointing to the unhappy apparatus, he cried out in the theatrical voice which he inherited from the tragedian Talma, "Friend, I promised to restrain my anger, and I have faithfully kept my word; give me back my promise, or you will see me expire before your eyes." The stranger had no alternative but to bow assent. You may imagine what followed—I will not attempt to describe the scene.

Report says that the assistant was sometimes a match for the professor. On one occasion M. Thénard ironically commiserated him in these words, "Poor fellow, you will never do any good." To which the other replied, "Sir, you compliment me; it is the very same thing Fourcroy predicted of yourself when you were his assistant."

Beneath that rough exterior, and that fiery temper, there lay an honest conscience and a warm heart. Again and again did his assistants tender their resignation, but it was never accepted; and public exhibitions of anger were followed by private acts of kindness. When in 1832, M. Thénard lay ill of a fever, his two assistants, M. Le Canu and M. Clément Desormes, undertook the duty of sitting up alternately by his bedside. One night the latter was so ill of a cough that the patient forgot his fever, in his anxiety to watch over his nurse.

M. Thénard died full of years, and rich in honours and titles.

2. *Baron Cauchy.*—At the suggestion of Professor Forbes, I had drawn up a brief notice of the life of our mutual friend M. Cauchy, when the biographical letter of M. Biot fell into my hands. This letter has enabled me to add certain details which I had previously been unable to supply, and to which the present sketch owes its chief interest. As however M. Biot's statements, in one or two

instances, differ from my own, which are based, for the most part, on M. Cauchy's writings, I have allowed the latter to remain as I originally penned them.

In Baron Cauchy, the world has lost the last of those eminent cultivators of mathematical science who sprung up in the early part of the present century, formed in the school of Laplace and Lagrange. The names of Poisson, Gauss, Fourier, Abel, Jacobi, and Cauchy, form a constellation of abstract mathematicians, such as the world never before saw existing together, and will probably never see again. Agustin-Louis Cauchy was born on the 21st of August 1789, the period of universal confusion throughout France. His father, who was keeper of the archives of the senate, appears to have been exempt from the turmoils which embroiled every grade of society at that time. Perceiving the mathematical bent of his son's mind, he took pains to bring him frequently under the notice of Lagrange. This illustrious philosopher interested himself in the education of the lad, and gave the father a piece of advice which no doubt greatly surprised him, and which, coming from such a source, it is worth our while carefully to note. These were his words:— "Do not allow your son to open a mathematical book, nor to touch a single diagram, until he has finished his classical studies." Sound and excellent advice under the circumstances. Preliminary education has for its object the cultivation of all the faculties, not the developement of any one to the exclusion of the others. It fulfils its functions as well when it tends to check and keep down an overwhelming bias in one direction, as when it aims at drawing out the dormant powers in another. The wisdom of the advice of Lagrange may be inferred from the whole life of Cauchy. In his classical studies he was eminently successful, and received the highest award of his class. The taste which he now acquired for languages never forsook him. In his later years he read deeply in patristic theology, and delighted in pouring forth his divinity for the instruction of the young. Nor did his exclusive devotion to classical study stand in the way of his professional advancement. After a single course of mathematics under a public professor, Duret, he presented himself, at the age of sixteen, for the entrance examination of the *Ecole Polytechnique*, and was ranked second on the list.

It is not necessary to trace, step by step, his advance in his profession. Suffice it to say, that he became *ingénieur en chef* in 1823, and was employed on many public works.

Prior to this date, however, he had been brought prominently before the world. The French Institute had proposed as the subject of the Prize Essay for 1816, the determination of the wave motion of a disturbed fluid. M. Poisson, who, as he himself states, had been for a long time engaged on this problem, sent in a first memoir on the subject in October 1815, followed by a second in December, There is reason to suppose, that one object which the Institute had in view in proposing this problem was to draw out M. Poisson. That any living man should have succeeded in wresting the prize from him, who was justly regarded as a giant in investigations of the kind, is matter of astonishment to this day. That that man should have been Cauchy, who justly looked up to Poisson as his model for imitation, and who, years after, acknowledges with gratitude his obligations to that great mathematician, as the guide of his early career, must have greatly surprised even Poisson himself; yet such was the fact. The prize was awarded to Cauchy on the ground of the greater generality and freedom from limitations which his solution of the problem presented. I am not sure that M. Poisson was satisfied with the decision. At any rate, his own memoir was immediately published, whilst that of M. Cauchy, who was not then a member of the Institute, lay twelve years in manuscript. In this case the Institute, by following their ordinary vicious practice, conferred a real benefit on science, by allowing M. Cauchy to add copious notes to his essay. The two works of Poisson and Cauchy now stand together as masterpieces of analytical investigation, and form the starting-points from which all future writers on the subject must commence their progress. Prior to this period, M. Cauchy had published several admirable papers on subjects connected with pure geometry; and the proof now afforded of the fertility of his genius would at once have secured him an admission into the Institute, had there been a vacancy. The termination of the brief struggle of the hundred days unhappily too soon created the desired vacancy, in a manner little to the benefit of M. Cauchy, who was named to fill it. The Institute had been remodelled by Napoleon in 1803, and the legitimate monarchy, on their second restoration, at once resolved to re-establish it in its original form. In effecting this re-establishment it is not much to be wondered at that the Government should see fit to strike out the names of two members, Carnot and Monge—names not more distinguished by the brilliant talent of their possessors, than by their connection with that of the first consul Napoleon. Great as was Cauchy's genius, aimable as was his disposition, it could not prevent his sharing in the general feeling of disgust and dissatisfaction at the expulsion of Monge. Connected as the latter had been with the revolution, he had raised his hand when in power only as a shield to protect his colleagues from the proscription of the Reign of Terror. To sit in his place was to participate in the obloquy attached to his removal. Looking at the matter from this distance of time, however, we cannot impute the slightest blame to Cauchy. He was a legitimist by conviction. In the depth of his ardent piety he believed that the interests of religion were bound up with those of the monarchy; and as he never for a moment doubted the propriety of the act which placed his name on the roll, so he accepted the appointment without hesitation, firmly and conscientiously believing that it was his duty so to act.

About the same time he was appointed a professor adjunct in the *Ecole Polytechnique*. He occupied besides two other chairs. The lectures which he delivered are well known to the world under the titles of "*Cours d'Analyse Algebrique*," "*Leçons sur les Calculs, &c.*," "*Resumé des Leçons sur le Calcul Infinitesimal*," "*L'application de l'Analyse à la Théorie des Courbes.*" He published also at this period various important memoirs, especially one on integrals taken between imaginary limits.

In 1826, he undertook the Herculean task of conducting and carrying on a scientific periodical, under the title of *Exercises de Mathématiques*, confined exclusively to his own writings. After the lapse of little more than four years the work had advanced into the fifth quarto volume, without any abatement of originality or of interest, when it received a sudden interruption. M. Cauchy, as we have said, was a warm adherent of the legitimate monarchy, and its overthrow was his own. Following the example of its predecessors, the new government demanded an oath of allegiance from all men holding public situations. This oath appears to have made no stringent demands, none which a scientific man might not safely have conceded, whatever his political principles. But M. Cauchy's conscience was tender even to excess; and although he had now a wife and two children depending on him, he resigned all his employments and retired into voluntary exile in Switzerland, sacrificing his prospects "to devotion to the unfortunate, and the sincere love of truth." The King of Sardinia, informed of the circumstance, created for him a Chair of Mathematics in Turin. This appointment he accepted, and lectured in the Italian language with great success. There he recommenced the publication of his *Exercises*, under the appellation of *ResumésAnalytiques*. Having remained in Turin about two years, the voice of his sovereign (Charles X.) called him to Prague, to take part in the education of the Count De Chambord. At Prague he was rejoined by his wife and family; and for the succeeding six years he attached himself to the persons of the royal exiles. Again he resumed his *Exercises*; and having, I believe, plenty of spare time on his hands, he appears to have amused himself with lithography. In this new form he issued his publications; and it is to be feared that a complete set does not exist. I have the impression that M. Cauchy informed me, with his own lips, that he did not himself possess copies of all his lithographed memoirs. At any rate, they are almost unknown even in France.

Charles X. died on the 6th of November 1837; and M. Cauchy's functions as tutor to the Count of Chambord having ceased, he returned to Paris in 1838, and resumed his place at the Institute. He now took the title of Baron Cauchy, but whether by succession or by creation I do not know. Having no public occupation, he divided his time between the pursuits of science and the performance of deeds of benevolence. In both his voluntary labours he was indefatigable. The time he bestowed on each seemed to preclude the possibility of his having a moment for attention to the other. During the last peaceful nineteen years of his life he published in the different volumes of the Institute, and in the *Comptes Rendus*, upwards of FIVE HUNDRED memoirs, besides a multitude of reports and criticisms. This immense mass of work abounds in new thoughts, new methods, and sweeping generalizations, and may be regarded as a vast storehouse from which the next generation of mathematicians will draw their resources. It is to be regretted that M. Cauchy did not concentrate his attention more. Many of his papers are in a very rude state, containing only the germ of an idea, which he failed fully to develope. In fact, during his later years he reminds one a little of Hooke, who was wont to rise at the conclusion of every memoir which he heard, and declare that he had something in store on the same subject. The notation, too, of some of his papers is a notation peculiar to himself; and the methods employed are often those of a new calculus, the *Calcul des Residus*, invented by him, but not generally adopted by mathematicians. All these circumstances will conspire to lock up M. Cauchy's papers for a considerable period. But no one hesitates about their value. In those subjects where the results of his analysis can be easily tested, such as in the determination of the motion of elastic media, with its application to the undulatory theory of light; or in the doctrine of planetary disturbances as applied to the movements of the small planet Pallas, M. Cauchy was, and will continue to be, the received authority.

No sooner had he settled at Sceaux, in the neighbourhood of Paris, than, for the fourth time, he commenced the publication of his *Exercises*, which he continued to the day of his death. The extraordinary amount of work thus performed by one man strikes the mind with astonishment. It is true that many of his papers are but the exhibition in type of the pages of his scribbling book. He had the habit during life of preserving all his loose thoughts and unsuccessful attempts, by working constantly on paper bound in volumes. Thus whatever he penned was sure to be preserved. We may perhaps be permitted to regret this circumstance, as its evident tendency was to present a bar to the operation of that polishing process which most writers find so essential to the success of their works. But M. Cauchy was not allowed to remain nineteen years in the silence of his study. On the 13th of November 1839, the *Bureau des Longitudes* called him to the place previously occupied by M. Prony. This was an unfortunate event. It was evident to all those who knew M. Cauchy that he would never consent to take the requisite oaths. Negotiations were accordingly at once set on foot by those who desired his presence amongst them, with the object of inducing the Government to dispense with the formality. Men of science of every shade of political opinion interested themselves in the matter; but without success. The Government did, indeed, consent to reduce the oath to the merest matter of form, but an absolute dispensation it would not concede; and Cauchy was less likely to move towards the opposite party than they towards him. With an obstinacy quite puerile, to use M. Biot's phrase, he doubled on their path at every turn they took to encompass him. His resolve rendered all their efforts hopeless; and finally his appointment was cancelled. Those only who know what Cauchy was capable of, will be able to estimate the loss astronomy has sustained from this untoward event.

In 1848 France saw another revolution, and a new republican government. Oaths were now dispensed with, and M. Cauchy resumed his Chair of Mathematics in the Faculty of Sciences. But the events of the 2d December 1851 once more unseated him. Again, the scientific men of France (to their infinite credit be it recorded) used every effort to induce the newly constituted authorities to make his an exceptional case, and dispense with every formality. At first without success; but after a while, when the Emperor had become securely established in his government, he had the good sense to cause M. Cauchy to be restored to his chair, fettered by no conditions. Whether from conscientious scruples or otherwise, it is certain M. Cauchy never appropriated to his own use one farthing of his salary. The whole was devoted to deeds of charity. As the dispenser of blessings to the poor, he knew neither monarchists nor republicans. In the neighbourhood of Sceaux, where he resided, he was the prime mover in every labour of love. On one occasion the mayor remonstrated with him on the prodigality of his beneficence. His reply was, "Be not concerned; I am only the channel; it is the Emperor that pays the money," alluding to his salary as professor.

The scientific character of M. Cauchy requires no exposition. I am content to adopt the judgment of a competent authority, the Dean of Ely, pronounced nearly a quarter of a century ago, which will be fully confirmed by future eulogists. "M. Cauchy," he says, "is justly celebrated for his almost unequalled command over the language of analysis."

With the private life of a scientific man the biographer has properly little to do. But in the present instance, the brilliant virtues of the Christian shine so brightly upon his genius, that the latter, dazzling as it is, fails to eclipse the former. M. Cauchy's labours among the infirm, the destitute, and the young, are the labours of a true apostle. His march was always forward: his watchword always duty. As seen by the eye of the man of science, he was absorbed in study; as seen by the eye of the man of God, he was absorbed in labours of love. In every scheme for the instruction, for the sustentation, for the elevation of his commune, he was ever active, ever devoted. No amount of labour, no sacrifice of time or of money, was too great for him. He was accustomed to wait on the mayor almost daily, and often several times in the day; and he brought with him all his resources of heart, of head, and of purse. Now to recommend a poor infirm man to the charity which primarily came from himself; now to suggest the adoption of an orphan whom he had hunted out; now to restore a wounded soldier to his family; now to organize a school; now to forward the working of an hospital. " He had (says the eloquent mayor of Sceaux) two distinct lives—the Christian and the scientific life—each so full, so complete, that it would have served to confer lustre on any name." A characteristic feature in his good works was that truly Christian one, that he conducted them without ostentation, and without assuming even the shadow of merit.

A little before his death, and when it was but too evident that his end was approaching, he was busily engaged with the curé of the parish in arrangements for the benefit of the people. Perceiving that he was overtaxing his strength, the curé besought him to take rest, adding, that in so doing, he would second the efforts of those who were praying for his restoration to health. His reply was in these words, and they are the last of his recorded words:—" Dear Sir, men pass away; but their works remain. Pray for the work."

I have a pleasing remembrance of the retired chateau at Sceaux, with its vine-trellised gardens; and of tho beaming countenances of M. Cauchy and his agreeable family. In that retreat all was as bright as the summer sky. To the great and good man, whose loss we now lament, it was the dawning brightness of the morn " that shineth more and more unto the perfect day."

The following Communications were then read :—

1. Excursions in the Troad, with Observations on its Topography and Antiquities. By Dr William Robertson, F.R.C.P.E. Communicated by Dr J. Y. Simpson.

The author had resided for fifteen months, in 1855–56, within a few miles of the Plain of Troy, and had made excursions over it at all seasons.

His paper commenced with a description of the western extremity of the Asiatic coast of the Hellespont, between Abydos and Koum Kaleh, including the River Rhodius and the sites of Dardanus, Ophrynium, Pteleos, Rhætium, and Novum Ilium, all of which he considered positively identified. A minute topographical account followed: first, of the valley of the Dumbrek (Simois); next, of the valley of the Mendere (Scamander); next, of the valley of the Kimair (Thymbrius of Strabo); and lastly, of the hilly country between these streams, and of the relics of antiquity which it included.

The author believed that Homer's Troy must have stood, like the Novum Ilium of Strabo, on the hill now called Hissarlik—that the mouth of the Scamander was formerly two miles to the east of its present main channel, and that the In-Tepeh-Osmak and Kalifatli-Osmak might be regarded as its terminations in the times of Homer and Strabo. He showed that these, and the other Osmaks in the valley of the Mendere, were at present merely winter channels of the river, and that in summer they would be dry nullahs, but for the drainings from the extensive marshes left by the winter inundations of the plain. He believed that the bay between Koum Kaleh and In-Tepeh was deeper in the days of Homer, and that its eastern extremity, in particular, had during the last 2000 years been materially encroached upon by deposits of mud and sand from the rivers and sea.

He remarked that Homer made no mention of a *river* Thymbrius, and that the Thymbra which is alluded to in the Iliad very probably stood in the valley of the Simois, to which it has ultimately transferred its name. The Thymbra and Thymbrius of Strabo were certainly situated near the modern farm of Ak-tchai-kioi on the Kimair.

An account was given of various excavations, made in 1856, in some very ancient places of sepulture at Ak-tchai-kioi, and among the ruins of Dardanus. In the former of these cemeteries the bodies had been buried, entire and unburnt, in very large earthen urns, along with pateræ and lachrymatories of materials and forms indicating the earliest stage of Grecian art. The cemetery at Dardanus was more modern; and the bodies, which had usually been burnt, were here found in rectangular cysts, built of flat stones or tiles, and carefully cemented. The pottery found at Dardanus was often of very elegant workmanship, and the painted or glazed figures upon it less rude than those observed at Ak-tchai-kioi; but it was singular that no medals, nor coins, nor even traces of inscription, had been found among these tombs.

2. On the Composition of the Building Sandstones of Craigleith, Binnie, Gifnock, and Partick Bridge. By Thomas Bloxam, Assistant Chemist, Laboratory of Industrial Museum. With a Preliminary Note by Professor George Wilson, Director of the Industrial Museum.

PRELIMINARY NOTE.

In prosecution of the analyses of Scottish building stones commenced last winter in the laboratory of the Industrial Museum, by the examination of the bed-rock from Craigleith quarry, four more sandstones have been analyzed since May 1856 by Mr Bloxam. The stones in question are the Craigleith liver-rock, and the Binnie sandstone, from the neighbourhood of Edinburgh, and the Gifnock and Partick Bridge stones, from the neighbourhood of Glasgow.

As in the case of the coarser Craigleith rock, the chief points inquired into, in the case of each stone, have been the following:—

1. The specific gravity.
2. The amount of water naturally present.
3. The amount of water absorbed by entire aqueous immersion under air.
4. The amount of water absorbed by partial aqueous immersion, distinguished in the sequel as absorption by "capillary attraction."
5. The amount of water absorbed by entire aqueous immersion under the air-pump vacuum.
6. The amount of substance soluble in pure water.
7. The amount of substance soluble in water saturated with carbonic acid.

8. The amount of substance soluble in dilute hydrochloric acid.
9. The amount of clay present.
10. The quantitative composition.

From the entire investigation it will be seen that, as in the case of the Craigleith bed-rock, water alone dissolves something from each stone; water charged with carbonic acid dissolves an additional amount of substance; and water containing mineral acids, effects still farther solution. The conviction I had long entertained, that the iron stains in sandstones are occasioned not only by the oxidation of iron pyrites, but by the solution of iron in water containing carbonic acid, and which led to the trial, in the case of the Craigleith bed-rock, of the action of carbonic acid water upon its powder, is now extended and confirmed.

The results in full are stated in the succeeding statements by Mr Bloxam, who has had the entire charge of the analytical inquiry. His interesting observation, that cobalt occurs in Craigleith stone, previously announced in relation to its coarser variety, is now extended to the denser liver-rock and to the Gifnock sandstone.

Copper also has been shown to be present in the Binnie sandstone, a metal not hitherto suspected to exist in rocks of its class. Mr Bloxam has also pointed out the occurrence of nodules of protocarbonate of iron in the Partick stone, a peculiarity which probably will not be found confined to that rock; since, in truth, it is but the most exaggerated form of that occurrence of carbonate of iron in sandstones, to which the extraction of iron from them by carbonic acid water pointed. Nevertheless, I was quite unprepared for the carbonate of iron occurring in separate masses of considerable magnitude, nor was it in consequence of any hypothesis, but solely by careful analysis, that Mr Bloxam made this curious discovery. The explicit table which he has constructed, and the commentary which precedes it, render any further remarks on my part unnecessary.

G. W.

1. *Craigleith Liver Sandstone.*

The experiments upon the Craigleith liver sandstone were made with carefully-selected specimens of the stone. The results are stated in full in the table.

2. *Binnie Sandstone.*

The second stone subjected to analysis was procured from Binnie quarry; it was chosen not only as a building material in great repute, but also with the view of investigating the bituminous matter which is both disseminated through it, and found in sufficiently large quantities to admit of a special inquiry.

In the specimen alluded to, the bitumen appeared in small spots, becoming more visible when the stone was heated to 212° Fahr. When held in a flame, it melted, burned, and left the stone quite white.

To the consideration of this curious substance the last part of this paper is entirely devoted; and the experiments upon the stone itself are given in the table.

I now proceed to a few remarks upon the bituminous substance already briefly noticed as occurring in the Binnie stone.

It is a brittle substance, resembling wax to the touch, fusing at 240° Fahr., and boiling above 680° Fahr.

It is slightly soluble in alcohol, imparting to it an acid reaction; it is somewhat more soluble in ether, in which case the solution also has an acid reaction. It is also soluble to a slight extent in bisulphide of carbon; turpentine, however, is its best solvent, giving a solution of a brown colour.

The specific gravity of the bitumen is ·955; when heated it completely melts, then boils, and finally burns away, leaving a trace of ash.

A large quantity of it was burned and the ash examined, when the following substances were found;—silica, iron, soda, and magnesia.

When subjected to destructive distillation, it furnishes two different products: the first solidifies as soon as it distils over; the second remains liquid even at 32° Fahr.; and exhibits the properties of paraffine oil.

The first product, when treated with ether, yielded paraffine in large quantity.

A quantitative estimation of the ash and volatile matter gave the following results:—

Volatile, ...	99·86
Ash, ...	·06
	99·92

Water ·68 per cent.

A portion of the bitumen was subjected to organic analysis with chromate of lead, and gave a mean result as follows:—

Carbon,	84·37
Hydrogen,	14·89
Water at 212° Fahr.,	00·68
Inorganic constituents,	·06
	100·00

3. *Gifnock Sandstone.*

The third variety submitted to investigation was from Gifnock quarry, situated between two or three miles north of Glasgow; it was procured from Mr Napier, chemist, Partick, Glasgow.

The stone appeared much disintegrated and easily broken.

The results of the experiments upon this stone, and also upon the Partick sandstone, may be seen by referring to the table.

4. *Partick Bridge Sandstone.*

The fourth stone made the subject of experiment was Partick Bridge quarry, about a mile and a half due west from Glasgow.

In the preliminary process of pulverization, preparatory to analysis, some pieces of a black-coloured substance, associated with iron pyrites, were found disseminated through the stone, which were carefully separated, and made the subject of special inquiry.

When heated, this substance blackened, due to the presence of a small quantity of organic matter; its solubility in different menstrua was ascertained, dilute hydrochloric acid being first added; it had, however, little or no action.

The probability of this substance being clay was suggested to me by others; but from its extreme hardness and general weight the supposition did not seem likely. I was led, therefore, to try it by fusion with alkaline carbonates. The fused mass was treated, as usual, with dilute hydrochloric acid, when a black residue was left, which entirely dissolved in more concentrated acid.

A small portion of this powder was collected and examined; it was attracted by the magnet, and its solution in hydrochloric acid yielded nothing but iron in the state of protoxide. This circumstance suggested the probability of the supposed clay being, firstly, clay very rich in protoxide of iron, or, secondly, entirely an iron compound, devoid, or nearly so, of clay; for, on examining the acid solution of the fused mass, nothing but a trace of alumina was discovered, at once proving the absence of all clay.

The black powder attracted by the magnet yielded by analysis 5·78 peroxide of iron, from 6·01 of substance; while, had the substance been magnetic oxide of iron, the amount of peroxide yielded would have been 6·63; so that we may safely conclude that the substance was nothing more than magnetic oxide of iron, produced during the fusion with the alkaline carbonate.

The next experiment that suggested itself was to try the action of more concentrated acid upon the supposed clay. The whole of the substance immediately dissolved in moderately strong hydrochloric acid, with the evolution of much carbonic acid gas; the solution on analysis yielded a large quantity of protoxide of iron, together with carbonate of lime, and traces of sulphate of lime, also alumina, magnesia, and soda.

As a conclusive experiment, the action of carbonic acid gas upon the substance suspended in water was tried. Upon filtering the liquid at the close of the experiment, and subsequently analyzing it, much protoxide of iron was dissolved.

It is obvious, from the foregoing remarks, that the pieces of substance found disseminated through the stone consist entirely of proto-carbonate of iron.

The ill effects of these nodules of proto-carbonate of iron are at once evident; for a block of stone freshly cut from the quarry exhibits no external mark of their presence within it to guide us, and it is not until the rain and air have had their full effect upon it for some time that the stain renders itself visible as a dark reddish-brown ring of peroxide of iron.

Analysis of Building Sandstones.

Name of Stone.	Specific Gravity.	Water naturally contained, or Loss on Drying, at 212° F.	Water absorbed by continued Immersion.	Water absorbed by Capillary Attraction.	Water absorbed under the Air-Pump.	Action of Water on the Stone.	Action of Carbonic Acid Water upon the Stone.	Action of dilute Hydrochloric Acid on the Stone.
Craigleith Liver-Rock.	2·432.	3·2 fluid ounces per cubic foot.	5· imperial pints per cubic foot.	5·11 imperial pints per cubic foot.	7·7 imperial pints per cubic foot.	6 ounces boiled on 400 grains for 1 hour 40 minutes, dissolved from it ·38 of a grain.	Dissolved Protoxide of Iron, Lime, and Soda.	Dissolved Silica, Alumina, Iron, Cobalt, Lime, Magnesia, and Soda.
Craigleith Common Rock.	2·443.	5·7 fluid ounces per cubic foot.	3·8 imperial pints per cubic foot.	4·2 imperial pints per cubic foot.	6·2 imperial pints per cubic foot.	6 ounces boiled on 400 grains of stone for 1 hour 40 minutes, dissolved from it ·35 of a grain.	Dissolved Protoxide of Iron, Lime, and Magnesia.	Dissolved Protoxide of Iron, Peroxide of Iron, Oxide of Cobalt, Manganese a trace, Alumina, Lime, Potassa, and Soda, in small quantity.
Binnie Stone.	2·413.	5·5 fluid ounces per cubic foot.	6·1 imperial pints per cubic foot.	5·5 imperial pints per cubic foot.	7·85 imperial pints per cubic foot.	6 ounces boiled on 400 grains, dissolved ·23 of a grain.	Dissolved Magnesia, Lime, Soda, with a trace of Iron.	Dissolved Iron, Lime, Magnesia, Potassa, and Soda, and Copper.
Gifnock Stone.	2·463.	1·3 fluid ounces per cubic foot.	6·7 imperial pints per cubic foot.	7·4 imperial pints per cubic foot.	8·9 imperial pints per cubic foot.	6 ounces boiled on 400 grains, dissolved ·26 of a grain.	Dissolved Protoxide of Iron, Lime, Alumina, and Magnesia.	Dissolved Silica, Protoxide and Peroxide of Iron, much Lime, Magnesia, Soda, a trace of Manganese, and Cobalt in larger quantity than any of the former.
Partick Bridge Quarry.	2·503.	2·2 fluid ounces per cubic foot.	7·05 imperial pints per cubic foot.	5·11 imperial pints per cubic foot.	7·7 imperial pints per cubic foot.	6 ounces boiled on 400 grains, dissolved ·11 of a grain.	Dissolved Protoxide of Iron, Lime, Magnesia, and Soda.	Dissolved Protoxide of Iron, Peroxide of Iron, small quantity; Lime, Magnesia, Alumina, Silica, and Soda.

COMPOSITION IN 100 PARTS.

	Craigleith Liver Rock.	Craigleith Common Rock.		Binnie Stone.		Gifnock Stone.		Partick Bridge Stone.
Silica,	96·99	96·95	...	92·66	...	85·55	...	84·85
Peroxide of Iron and Alumina,	2·95	2·30	...	4·88	...	6·55	...	9·35
Water,	·13	·23	Organic Matter,	2·23	Carbonate of Lime,	7·90	Carbonate of Lime,	4·65
Lime and Magnesia, Oxide of Cobalt, and Alkalies,	00·00	·52	Water,	·23	...		Magnesia,	·45
					Water,	·05	Water,	·08
							Alkalies,	·62
	100·07	100·00		100·00		100·05		100·00

The following Donations to the Library were announced:—

American Journal of Science and Arts, conducted by Professors Silliman and Dana, November 1857. 8vo.—*From the Editors.*

Report on the Observatories of His Royal Highness the Maha Rajah of Travancore, at Trevandrum, and on the Agustier Peak of the Western Ghats. By John Allan Broun, F.R.S., Director of the Observatories. Trevandrum, 1857. 8vo.—*From the Author.*

Natuurkundige Verhandelingen van de Hollandsche Maatschappij der Wetenschappen te Haarlem Tweede verzameling, dertiende Deel. Haarlem, 1857. 4to.—*From the Society.*

Journal of the Statistical Society of London. December 1857. 8vo.—*From the Society.*

Returns of Births, Deaths, and Marriages registered in the eight principal towns of Scotland. November 1857. 8vo.—*From the Registrar-General.*

Journal of the Geological Society of Dublin, Vol. vii., Part 5. Dublin, 1857. 8vo.—*From the Society.*

Thirtieth Annual Report of the Council of the Royal Scottish Academy of Painting, Sculpture, and Architecture. Edinburgh, 1857. 8vo.—*From the President and Council of the Academy.*

Report of the Geological and Polytechnic Society of the West Riding of Yorkshire. 1856–7. 8vo.—*From the Society.*

Memoirs of the Literary and Philosophical Society of Manchester. Second Series, Vol. xiv. London, 1857. 8vo.—*From the Society.*

Meteorological Observations and Essays. By John Dalton, D.C.L. Second edition. Manchester, 1834. 8vo.—*From the Philosophical Society, Manchester.*

A New System of Chemical Philosophy. By John Dalton. Vols. i. and ii., Part 1. 8vo.—*From the Philosophical Society, Manchester.* 8vo.

Publications of the Dépôt de la Marine, viz:—

Collection of Charts.

Description Nautique de la Cote n. du Maroc, par C. A. Vincendon-Dumoulin et C. P. De Kerhallet. Paris, 1857. 8vo.

Instructions pour entrer dans le port d'Alexandrie. Paris, 1856. 8vo.

Instructions Nautiques sur les Mers de l'Inde, par James Horsburgh. Traduites de l'Anglais en 1857, par M. le Predour. 2^e edition. Tome deuxième. Paris, 1856. 4to.

Instructions sur la Nouvelle-Calédonie, suivies de Renseignements Hydrographiques et autres, sur la Mer du Japon et la Mer d'Okotsk, par M. Tardy de Montravel. Paris, 1857. 8vo.

Supplément au Pilote de la Mer Baltique. Paris, 1857. 8vo.

Annales Hydrographiques, Recueil d'Avis, Instructions, Documents, et Mémoires, relatifs a l'Hydrographie et a la Navigation, publiés par le Dépôt des Cartes et Plans de la Marine. Paris. 1854–5, 1856, 1857.

Description des Iles et des Passages compris entre la partie nord de l'Ile Luçon et les Iles du Japon. Par M. A. Le Gras. Paris, 1857. 8vo.

Observations Chronométriques et autres, faites en 1853 dans l'Archipel des Pomotous, par M. Parchappe et M. de la Marck. Paris, 1857. 8vo.

Explication et Usage des Wind and Current Charts. Par M. E. Tricault. Paris, 1857. 8vo.

Annuaire des Marées des Côtes de France, pour l'an 1857, publié au Dépôt de la Marine sous le Ministère de M. l'Amiral Hamelin, par A. M. R. Chazallon. Paris, 1856. 16mo.

Phares des Mers du Globe, d'aprés les Documents Français et Étrangers recueillés au Dépôt des Cartes et Plans de la Marine, et publiés par Alexandre Le Gras. Paris, 1856. 8vo.

Manuel de la Navigation dans le Rio de la Plata. Par A. Boucarut. Paris, 1857. 8vo.

Observations sur la Navigation des Paquebots qui traversent l'Atlantique. Paris, 1856. 8vo.

Observations Générales sur l'Ocean Pacifique, par C. Phillipe de Kerhallet, suivies des Prescriptions Nautiques pour echapper aux Ouragans. Deuxième edition. Paris, 1856. 8vo.—*From the Dépôt Général de la Marine.*

Mémoires de l'Academie Impériale des Sciences de Saint Petersbourg. Sixième serie. Sciences Mathématiques et Physiques. Tome vi. St Petersburg, 1857. 4to.—*From the Academy.*

Archives du Museum d'Histoire Naturelle publiées par les Professeurs-Administrateurs de cet établissement. Tome ix., liv^{r} 4ème. Paris, 1856–7. 4to.—*From the Museum.*

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe, Band xxiii., heft 2, xxiv., hefte 1, 2; Philosophisch-Historische Classe, Band xxiii., hefte 1, 2, 3, 4. Wien, 1857. 8vo.—*From the Vienna Academy of Sciences.*

Denkschriften der K. Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe, Dreizehnter Band. Phil.-Hist. Classe, Achter Band. Wien, 1857. 4to.—*From the same Academy.*

Monday, 4th January 1858.

THE RIGHT REV. BISHOP TERROT, V. P., in the Chair.

The following Communications were read:—

1. On the Structure of the Reproductive Organs in certain Hydroid Polypes. By Dr Allman.

Most of the observations contained in the present communication were made some years ago, and during the last autumn the author had an opportunity of repeating many of them and of adding some others. His object in now bringing them together was, that by being thus placed in possession of sufficient material, we might be enabled to make a useful correlation of the ascertained facts, so as to obtain, if possible, some more general expressions for the phenomena presented.

To arrive at such results, it was found absolutely necessary to introduce some new terms; for in many cases, parts requiring precise notions had no distinctive appellation whatever, while in other cases they had been known by names which convey an entirely false idea of their nature and significance.

Definition of Terms.

The parts of the hydroid zoophytes, on which devolve the office of perpetuating the species by the exercise of a true generative function, as distinct from simple gemmation, show themselves, as is well known, under the condition of external buds, which are produced in various forms and in various positions on the animal. To these buds, which are truly sexual, being in some cases male and in some female, the author proposes to give the name of *gonophore* (γονος, φορεω).

As an essential portion of the gonophore, we invariably find one or the other of two different kinds of bodies. One of these presents the form of a closed sac, in which a more or less disguised medusoid structure may in almost every instance be detected. For these bodies he proposes the name of *sporosacs* (σπορα, σακκος).

The other differs in no respect from a gymnophthalmous *medusa*, and may conveniently be designated by this name.

Both sporosacs and medusæ contain the immediate products of the generative system, certain individuals of each producing ova, and certain others spermatozoa.

In some cases the gonophore has only a single sporosac, or a single medusa, and these spring directly from the cœnosarc of the zoophyte. In other cases these bodies are numerous, or, if single, do not spring directly from the cœnosarc of the zoophyte, but from a special organ (blastostyle) to be presently described. In the former case, the gonophore may be called *simple* (*Gonophora simplex*); in the latter, *compound* (*Gonophora composita*).

The simple gonophore consists essentially of a sac, which is a mere extension of the ectoderm of the zoophyte invested or not invested by a polypary, and containing within it in some cases a sporosac, in others a medusa. To this sac the author gives the name of *ectotheque* (εκτος, θηκη).

A correct notion of a compound gonophore may be best obtained by referring to some illustrative example such as that afforded by a Laomedea.

In this genus the gonophores are produced near the axils of the ramuli in the form of oval hollow bodies or capsules, invested like the stems and ramuli by a distinct polypary. The axis of the capsule is traversed by an extension of the cœnosarc of the branch in the form of a tubular column, from whose sides there bud forth in some cases numerous sporosacs, in other cases medusæ, each with an ectothecal investment from the column. For this column the author proposes the name of *blastostyle* (βλάστη, στύλος).

In some cases (e.g. *tubularia*) the compound gonophore is destitute of its investing capsule, and then presents merely the condition of a naked blastostyle with its sporosacs (or medusæ ?).

The medusæ, like the gymnophthalmæ generally, consist of an *umbrella* or *mantle* with radiating and circular canals, and with a central projecting organ, in which the stomach is excavated, and which carries the mouth at its extremity. To this central organ the term peduncle has commonly been given, a name which conveys a wrong idea as suggestive of an organ of attachment and support. It is also frequently called the stomach, a term also obviously incorrect, as the true stomach may really occupy but a small portion of the entire organ. Huxley,* seizing, as the author thinks, upon its true significance, names it *polype*, but as it will be more convenient in the present investigations to distinguish it from the ordinary nutritive polype of the colony, it is proposed to speak of it under the name of *manubrium*, a term suggested by its position with regard to the mantle being such as to admit of a comparison with that of the *handle* of an umbrella.

The sporosacs consist of parts which have their strict homologues in the medusæ. These parts will therefore be spoken of under the same names as those of their equivalents in the medusæ.

These preliminary remarks will render easily intelligible the new terms which, after much consideration, the author deemed it necessary to introduce, as the only way by which cumbrous circumlocution can be avoided and precision given to our descriptions; and he proceeded in the next place to describe the structure of the reproductive system in certain species which have in this respect either never received, so far as he is aware, the attention of the comparative anatomist, or which, though studied to a certain extent, still present certain points worthy of attention, but which have hitherto escaped notice.

Hydractinia echinata.

In *Hydractinia echinata* the gonophores are borne upon certain polypes, which, as is well known, are destitute of tentacles and mouth, and differ also in some other respects from the other digestive polypes of the colony.† The gonophores surround the naked stems of

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* Lectures on General Natural History in *Medical Times*.

† I have observed in these generative polypes an oval mass nearly filling the cavity of the body. It is developed from the endoderm, and projects from the floor of the cavity. It reminds one of the manubrium of a sporocyst, but is apparently solid.

the polypes at a short distance behind the distal extremity. They may be seen to consist externally of an investing sac (ectotheque), which is a simple extension of the ectoderm of the polype, like it containing thread-cells, and totally destitute of polypary.

Immediately within this is another sac (sporosac), in which the indications of decided structure are very obscure. The second sac immediately invests the mass of ova or spermatozoa which occupy the space between its wall and a well-developed manubrium, which lies in the axis of the sac. The manubrium is a simple diverticulum of the endoderm of the polype, its cavity freely communicating with that of the latter. I could find no evidence of an ectodermal layer upon it. There are no gastrovascular canals.

I have not succeeded in making out any further structure in the gonophore of Hydractinia, which may be assumed as a type of the simple gonophore.

Hydractinia echinata is strictly diœcious, the male and female gonophores being always separated, so as to occupy distinct colonies.

Coryne ramosa.

The gonophores here belong to the simple type. They are borne upon the clavate body of the polypes, where they are scattered irregularly among the tentacula.

They are of a nearly spherical figure, and are attached to the polype by a short peduncle.

The manubrium of the sac is large and simple,—there are no radiating canals.

In the female gonophores the ova are numerous, and may be seen in their young state to be each contained in a very delicate membraneous cæcal tube of a pyriform shape, which closely embraces the ovum, and is attached by its narrow extremity, which constitutes a sort of neck to the base of the manubrium. The germinal vesicle and germinal spot are distinct. As the ova advance towards maturity, they appear to rupture the confining membraneous tube, and then lie free in the cavity of the gonophore.

In the male gonophores, while they cannot be externally distinguished from the female, the sporosac is filled with the spermatogenous cells. These may be seen, under slight compression, to be arranged in radiating lines, which, with a little careful examination, may be traced to the base of the manubrium. That these lines represent exceedingly delicate tubules, filled with the spermatogenous cells seems evident, and then they will be the exact equivalent of the pyriform ovigerous tubes of the female. It is quite possible, that in both the male and female sacs, the tubes containing the spermatozoa in the one, and the ova the other, open into the cavity of the manubrium; and thus facility would be at once afforded for the spermatozoa to gain access to the ova. I have never, however, succeeded in demonstrating such a communication.

Indications of the ova and spermatogenous cells being confined at an early period within delicate membraneous tubes may be witnessed in other species, but in no case have I succeeded in demonstrating such a condition so plainly as in the present species.

The spermatozoa have the usual form of caudate corpuscles. The zoophyte diœcious.

Clava multicornis.

In this species, the gonophores are borne upon the clavate body of the polype, just where it passes into the stem, and immediately behind the posterior tentacula. They are compound, each consisting of a cluster of sporosacs attached to a short blastostyle, but are destitute of investing capsule. I have observed in the same colony two kinds of polypes,—the ordinary tentaculiferous polypes, and others destitute of tentacula, and consisting merely of a columnar stem, scarcely clavate at its extremity, and destitute of mouth. The gonophores were borne on both kinds of polypes. The male and female gonophores are separate on distinct colonies.

The manubrium of the sporosac is simple; and there are no radiating canals. In each sporosac (female) there is usually a single ovum, though I have occasionally witnessed two. The germinal vesicle is visible in the ovum, and the process of segmentation may be distinctly traced.

As development proceeds the ovum becomes elongated, and it may be seen to be invested by a proper membrane, apparently structureless. Within this membrane a distinct dermal layer now begins to be differentiated from the ovum; while at the same time a cavity is formed within it, and the embryo may now frequently be seen doubled upon itself. At this stage it is ready to escape from the sporosac, which gives way for its exit, and the embryo may then be seen swimming through the surrounding water by the aid of the minute vibratile cilia which clothe it entire surface. It is of an elongated conical figure, but very contractile. When fully extended, its surface is smooth; but when contracted, it is thrown into transverse rugæ, which give it a close resemblance to an annuloid animal. The rugæ never show themselves on the thick extremity, which always continues smooth, even in extreme contraction.

Tubularia coronata.

In the *Tubularia coronata* (Van Ben.) the gonophores are borne upon the body of the polype immediately within the posterior circle of tentacula. They consist of a long blastostyle carrying numerous sporosacs, and are destitute of investing capsule. The zoophyte is diœcious. In referring to my notes of this species made some years ago, but which I have not since had an opportunity of verifying, I find that the phenomena presented by the development of the ovum point to a type quite different from what prevails in that of the sertularian zoophytes, and in Clava, Coryne, &c. In the present species, the embryo is not the result of a transformation of the entire ovum, as in the instances just mentioned, but is produced from a definite portion of the vitellus, the remainder of the vitellus being absorbed by the developing embryo.

The embryo itself is developed on an entirely different plan from that of the sertularidans, &c. Instead of presenting the form of an elongated ciliated cone, destitute of all appendages, as in the latter, it assumes here somewhat that of two short, thick cones placed base to base, surrounded at the place of contact by a circle of long filiform tentacula slightly thickened at the ends.

In this condition it leaves the sporosac, and by the aid of its long tentacula, moves about freely in the water.

As development proceeds, and apparently before it had left the gonophore, a mouth is found upon one apex of the double cone, and round this mouth, a circle of short tentacula afterwards sprout out. In a further stage, we find that the opposite apex has become elongated into a hollow peduncle, by which the young Tubularia permanently fixes itself to some solid body, while the clavate condition of the extremities of the tentacula entirely disappear, and these organs acquire a uniform thickness throughout.

Little more is now needed to bring it into the form of the adult Tubularia.

Laomedea flexuosa. Hincks.

In this zoophyte the gonophores are of an oval form, generally truncated at the summit. They consist of a blastostyle, with sporosacs and investing capsule.

The blastostyle is in the form of a cylindrical column expanded into a sort of head at its distal end, and having a distinct ectoderm and endoderm inclosing a central cavity, which freely communicates with that of the cœnosarc of the polype.

From the sides of the column numerous sporosacs bud forth, carrying with them an ectothecal investment from the ectoderm of the blastostyle, and, being more mature the nearer they approach to the distal extremity of the blastostyle. They possess a large simple manubrium, and are destitute of gastrovascular canals.

The whole is surrounded by the oval capsule. The formation of this capsule may be observed by watching the growth of the gonophore. In the young state of the gonophore one or more lacunæ may be seen in the ectoderm of the blastostyle. These become confluent and soon extend round the whole blastostyle, thus separating the ectoderm into two distinct layers by a true process of chorization. The inner layer still remains adherent to the endoderm; but the outer layer recedes farther and farther from the central column, to which it remains directly attached only at the proximal and distal ends, thus forming the walls of an external capsule whose axis is occupied by the blastostyle, and whose cavity is nothing more than a large lacuna. Into this lacuna the sporocysts bud forth from the sides of the blastostyle. While the gonophore is yet young numerous irregular fleshy bands may be seen stretching across the cavity from the blastostyle to the external wall. These bands are the remains of the original union between the two layers into which the ectoderm of the blastostyle has split. They are generally torn, and disappear as the capsule, increasing in size, becomes more and more widely separated from the blastostyle; but they are also occasionally more or less visible in the full-grown gonophore. In the meantime, the ectodermal layer, thus separated from the blastostyle, becomes invested by a distinct chitinous polypary; and after the capsule has acquired its full size, this ectodermal layer generally disappears along with the connecting bands just described, and the capsule is now solely represented by the chitinous secretion of its original wall.

Each sporosac (female) produces a single ovum in which the germinal vesicle and spot are distinctly visible. The segmentation of the vitellus can be easily followed; and as the segments become smaller and more numerous, a nucleus may be distinguished in each. The ovum at the same time increases in size, and the manubrium of the sporosac becomes more or less displaced. After the disappearance of the mulberry-like condition, an external dermal layer becomes distinctly differentiated. It is composed of elongated cells placed perpendicularly to the surface, and may be seen to enclose a minutely granular mass. The ovum, at the same time, becomes considerably elongated, and may be soon seen doubled on itself. It now acquires cilia on its surface, and is ready to escape as a free embryo from the sporosac, which accordingly becomes ruptured to allow of the exit of the embryo, which ultimately gains its final freedom through the summit of the capsule. The embryo now moves freely, by the aid of its ciliated surface, through the surrounding water. It is of a conical or pyriform figure, but very contracted and mutable. Its interior may be seen to be hollowed out into a cavity, but as yet no mouth can be demonstrated.

I have not yet succeeded in witnessing the change of the locomotive to the fixed state of the polype, but it is doubtless similar to what has been observed in the allied forms.

The male capsules and sporosacs resemble the female so closely as only to be distinguishable from them by an examination of the contents of the sacs. These contents consist of a mass of spermatogenous tissue, which replaces the single ovum of the female.

The spermatozoon consist of caudate corpuscles, about $\frac{1}{5000}$ of an inch in diameter.

Laomedea flexuosa is strictly diœcious, the male and female gonophores always occurring on separate colonies.

Antennularia antennina.

The gonophores in *Antennularia antennina* are borne upon the upper side of the short processes which, springing in verticels from the main stem, give support to the polypiferous ramuli.

Each process carries a single gonophore, which is of an oval form, and presents, as it approaches maturity, a subterminal aperture directed towards the main stem of the zoophyte.

The gonophore is constructed on the compound type, and presents a blastostyle, sporosacs, and investing capsule. The sporosacs are given off near the base of the blastostyle: there is usually but a single one; occasionally, however, two may be observed in one gonophore. The manubrium is well developed, but there are no gastro-vascular canals.

In the female sporosae a single ovum makes its appearance. This at first occupies but a small portion of the cavity of the sporosac, and permits the long manubrium to be easily seen, but as it grows it entirely fills the sporosac, and ultimately, by its pressure, causes the absorption, first of the walls of the sporosac, and at last of the manubrium and blastostyle, until nothing remains but the external chitinous envelope of the capsule, with the ovum floating freely within it.

I have also frequently observed floating along with the ovum in the gonophore, a small free sporosac with well developed manubrium, but containing neither ova nor spermatozoa. It was probably a bud, formed like the ordinary sporosacs from the blastostyle, but never developing within it the generative elements.

The male gonophores resemble the female in all respects except in the contents of the sporosacs, which are here spermatozoa, instead of ova. In the young gonophores the sporosac is filled with semi-fluid contents, which are found to be composed of a mass of cells, frequently with secondary cells, " vesicles of evolution," in their interior. The secondary cells, whether free or contained in the mother-cells, are filled with a corpuscular fluid, in the midst of which may generally be demonstrated a larger corpuscle, which under the action of acetic acid is rendered especially apparent as a bright spherical nucleus.

The contents of the sporosac, which were at first sufficiently transparent to admit of the manubrium being clearly seen in the midst of them, become more and more opaque as the gonophore advances to maturity, and finally completely conceal the peduncle. If the contents be now liberated by rupture of the sporosac, they will be found to consist, partly of free active spermatozoa, and partly of cells (vesicles of evolution), with the spermatozoa still confined in them.

The spermatozoa consist of a minute oval or rather pyramidal body with a delicate caudal filament. In each of the vesicles of evolution there may be distinctly seen a somewhat elongated nucleus which is the body of the spermatozoa, as yet confined in its vesicle of evolution, and is plainly derived from the original spherical nucleus of the vesicle.

The ovum, from the earliest period at which I have observed it, appears as an opaque yellowish body. From an early stage it may be seen to consist of a mass of minute spherical cells filled with a yellow fluid, while the whole is enveloped in a delicate vitelline membrane. In the young ovum the germinal vesicle may be seen as a single large spherical cell included in the midst of the other contents, whose opacity, however, makes it necessary to subject the ovum to compression before we can bring into view the germinal vesicle, which may then be completely isolated as a separate cell on the field of the microscope. In the more advanced ovum the germinal vesicle has entirely disappeared; but I did not succeed in satisfactorily tracing any very distinct segmentation, owing, doubtless, to the unusual opacity of the ovum. The whole ovum becomes gradually converted into the embryo. As the time approaches when it is to leave the gonophore, we find it capable of changing its form by slow contractions, and it soon escapes by the aperture of the gonophore, and enters on the external world as a free embryo.

It is now of a more or less conical form, though continually changing its shape by slow contractions. By this time the ectoderm and endoderm are both differentiated, and a central cavity has already made its appearance; but there is as yet no trace of a mouth; thread-cells, the characteristic product of the ectoderm, are copiously developed in it, and its surface is clothed with very minute cilia, which, however, in all the examples I examined, were so enveloped in a mucous investment as to impede their action, and render them powerless as organs of locomotion. The embryo creeps about slowly upon the sides of the glass jar in which it is confined, avoiding the light side of the vessel.

After enjoying for a period its locomotive stage, the embryo fixes itself to the side of the jar by one extremity (the wider?) which then extends itself by means of radiating elongations into a little disc of a regular stellate form. From the centre of the free surface of the disc a cylindrical column now rises perpendicularly, and the whole becomes invested, at this stage, with a delicate transparent polypary. The column continues to grow longer, and now presents at intervals a shallow constriction. The cœnosarc which fills its axis is at first a simple tube with its endoderm and ectoderm; but it soon becomes resolved into the distinct tubules which characterise the cœnosarc in the stem of the adult.* The currents in these tubules are very evident, but are quite independent of one another—sometimes they may be all seen running down, sometimes running up; some down in one or two tubes, up in the others; sometimes the current will be very active in some, and at rest in the others.

From the basal disc small tubular filaments are prolonged to constitute the commencement of the matted root-like base of the mature colony.

From the parts of the stem where the constrictions show themselves, short, thick processes are shot out alternately at each side, so that the stem now presents a slightly zigzag form. From the upper side of each process a pair of the peculiar little cup-like organs, characteristic of the adult zoophyte, are produced, and on its extremity the first joint of the polypiferous ramulus makes its appearance. This joint is soon followed by another, and the ramulus gradually elongates itself by the necessary multiplication of joints. We have now a condition of the zoophyte very remarkable from the fact of its polypiferous ramuli presenting a strictly alternate arrangement, no tendency to the verticellate disposition of these ramuli in the adult being yet apparent.

Beyond this point I have not been yet able to follow the development of the young Antennularia.

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* In the main stem of the adult, the disposition of the cœnosarc is very peculiar. Instead of forming a single tube, it consists of numerous separate tubules, each with its ectoderm and endoderm. The tubules lie close upon the polypary, and leave an unoccupied space in the axis of the stem. They are connected to one another by an extension of the ectoderm, which thus forms a continuous lining of the polypary. In some parts the tubules of the cœnosarc run straight and parallel to the axis of the stem, in others, they are more or less curved, and frequently connected by transverse but irregular branches, so as to present a reticulated arrangement. The motion of the contents of the tubules can be distinctly witnessed in them. This complex structure of the cœnosarc disappears in the ramuli, the separate tubules here giving place to the ordinary simple tube.

Campanularia caliculata. Hincks.

I obtained this species on the 24th September 1857, from rock pools near low-water mark in Courtmasherry Harbour, with the gonophores. I obtained it afterwards in considerable quantities towards the end of the following October, from the same locality, adhering to *Delesseria sanguinea*, brought up on the long lines of the fishermen, but it was then almost entirely destitute of gonophores.

The gonophores are borne on the creeping stolon, to which they are attached by a short peduncle. They are of an irregular oval shape, with the summit truncated.

The blastostyle, in every case I examined, carried one large sporosac, which occupied about the upper two-thirds of the gonophore, and one smaller, and less developed, springing from the blastostyle near its base.

The sporosacs present some interesting peculiarities. The manubrium is obsolete, but four gastrovascular canals extend from the base of the sac to the summit, where they terminate in blind extremities. These canals send out short, lateral, alternate branches between every two of which, in the female sporosacs, an ovum is embraced. The germinal vesicle and spot are distinctly demonstrable, and the ovum is itself invested by a delicate membranous sac, which confines it in the sinus between the branches of the gastrovascular canals.

I had no opportunity of observing the development of the ovum.

Plumularia pinnata.

The gonophores, which are compound, are of an oval form, sometimes smooth, sometimes with a few irregular spiny longitudinal ridges. They are borne on the central stem or rachis, chiefly towards its attached end.

The blastostyle is but moderately developed, and carries usually only a single sporosac; but I have occasionally met with two or three. The manubrium, after advancing for a short distance into the sporosac, becomes much, but irregularly, lobed. Into these lobes the cavity of the manubrium is continued, and they may be fairly taken to represent the gastrovascular canals, which have no further equivalent in this species. In very young sporosacs the manubrium appears quite simple, but as the sporosac advances towards maturity the lobed condition becomes apparent.

The ova vary in number. I have occasionally found but a single one in each sporosac, though most usually from three to eight. They present the germinal vesicle and germinal spot, and may be observed to undergo segmentation.

The ciliated embryo is of the usual conical form. When about to change to the fixed state it attaches itself by one extremity, which becomes extended in the form of a four-lobed star, resembling a Maltese cross, from whose centre rises perpendicularly the primordial stem of the future zoophyte, at first in the form of a small cylindrical process, which elongates itself more and more, becoming at the same time invested with a delicate polypary.

We next find that on one side of the young stem a cell is formed in which the cœnosarc becomes developed into a polype.

Beyond this point I had no opportunity of observing the progress of development.

I have found the male gonophores on the same stem with the female, so that here the usual diœcious condition is departed from. The male gonophores are smaller and much less numerous than the female. The manubrium is less distinctly lobed, and is surrounded by a mass of spermatozoa instead of ova. The spermatozoa consist of a minute, somewhat pyramidal, body about $\frac{1}{5000}$ of an inch in diameter, with a caudal filament. They are developed in vesicles of evolutions, from which they seem to be produced by a transformation of the nucleus.

I obtained the *Plumularia pinnata* in abundance with the reproductive capsules, during the months of September and October, in rock pools near low-water mark at Lisnaleen.

Plumularia cristata.

Plumularia cristata is very remarkable, by a singular arrangement destined for the protection of its gonophores.

These are borne on certain peculiarly metamorphosed ramuli, which we must be careful not to confound, as has hitherto been done, with the proper gonophores of other zoophytes, and for which, believing it therefore necessary to give them a special name, I propose the term *corbulæ*, suggested by their basket-like form. In these corbulæ the proper gonophores are contained. The peculiar metamorphosis of the ramulus, which results in the formation of a corbula, consists in its developing from its sides alternate leaflets, which have their edges at first entire, but which afterwards become deeply serrated. As the leaflets increase in size they direct themselves vertically from the upper surface of the ramulus, and those of one side arch over, so as to approach those of the opposite. They are at first free, but they afterwards become intimately united at their edges, while those of one side ultimately coalesce with those of the other by their summits, and thus form a completely closed receptacle. Each leaflet contains a cavity which is only a prolongation of that of the ramulus.

In this receptacle the gonophores are produced. They spring from the upper side of the metamorphosed ramulus at the point where the leaflet leaves it, and take the place of the polype cells on an ordinary ramulus. They begin to be produced at an early stage of the corbula, and may be easily examined in the young corbula while yet open.

The metamorphosed ramulus generally remains unchanged for a short distance from its origin, and here may be seen bearing one or two ordinary polype cells.

About twelve gonophores are generally contained in each corbula; they are of the simple type, of a regular oviform figure, and are invested with a delicate extension of the polypary. The sporosac has a well-developed manubrium, which is quite simple, and extends nearly from the base of the sac to the summit. I have not found more than a single ovum in the female sporosacs I examined. In the male sporosacs, the cavity is filled with the spermatogenous tissue.

General Conclusions.

A comparison of the different forms of gonophore presented by the several species just described, and by some others not included in the present paper, shows that they are referable to three distinct types.

1. The *simple gonophore*, such as we find in Hydractinia, Cordylophora, &c.

2. The *naked compound gonophore* consisting of blastostyle and sporasacs, but destitute of investing capsule. Examples of this form are found in Tubularia and Clava.

3. The *capsular compound gonophore*, consisting of blastostyle and sporosacs, and having the whole invested by a distinct capsule. This type occurs in Campanularia, Laomedea, &c.

The gonophores may present a further remarkable condition, in having a number of them grouped together and included in a common receptacle formed by modified ramuli, as in *Plumularia cristata.*

Besides the above types, certain interesting modifications of form are presented by the sporosacs.

In these the manubrium may be

1. a simple diverticulum from the cœnosarc or the blastostyle, as in Hydractinia, Laomedea, &c.

2. It may be irregularly lobed, as in *Plumularia pinnata.*

3. It may send off from its base true gastrovascular canals, as in Cordylophora.

4. It may be completely suppressed, while well-developed gastrovascular canals spring from the base of the sporosac. This condition we find in *Campanularia caliculata.*

In the development of the embryo, we are probably justified in distinguishing two distinct types, though further observations will be needed before we can consider the generalization involved in this assertion as absolutely established.

1. The embryo may be developed directly from the whole vitellus, and will then always(?) present the form of a ciliated conical body.

2. The embryo may be developed directly from only a part of the vitellus, and will then always (?) present the form of a non-ciliated actiniform body.

2. On the Focal Adaptation of the Eye in Man and some Animals. By Dr James Black, F.G.S. Illustrated by enlarged diagrams.

After several introductory observations on the refractive condition of the human eye in infancy, in the prime of life, and in old age; and also in some tribes of artizans, in shepherds, and in mariners, with notices of the focal adjustment in the eyes of oxen, common fowls, and in fishes, as the cod and haddock, the author examined the different theories which have been advanced to account for this adapting power, and expressed his strong opinion that the external muscular apparatus was the principal and initiating agent.

3. Note on the Black Lustrous Varnish of ancient Pottery.

By John Davy, M.D., F.R.SS. L. & E., &c.

So far as my reading extends, the nature of the black varnish of the ancient Greek and Etruscan vases is still undetermined.

From the experiments I have made, operating on very small quantities, abraded from vases which were taken from tombs in the Ionian Islands, I have been led to the conclusion, that it is a vitreous matter, coloured by black oxide of iron, probably mixed with particles of metallic iron, to which its peculiar lustre may be owing.

It is, I find, of the hardness of glass, brittle and opaque. In powder or small fragments, it is powerfully attracted by the magnet. Before the blow-pipe it is fusible, its colour remaining unchanged, however powerfully it may be urged by the flame. It is insoluble in the nitric and muriatic acids, and also in the nitro-muriatic, and without change of colour; but, when fused with boracic acid, and then acted on by muriatic acid, its colouring matter is dissolved, siliceous matter remaining, and the solution is slightly precipitated by ammonia.

Considering this glazing as a compound of silica and of an alkali, or of an alkaline earth, coloured by iron, it may, I presume, be inferred, that it was applied to the earthenware in the form of a paste, and that the vessels were afterwards subjected to a temperature sufficiently elevated to melt the paste, and convert it into glass, but not high enough to fuse the substance of the pottery, which I find is fusible at a very high temperature. It may also, I think, be inferred, that the ferruginous colouring matter was mechanically mixed with the paste, before being applied;—an inference I am led to, from the circumstance, that where the varnish is very thin, it is no longer opaque,—the red colour of the clay is seen through it; and, on minute inspection, with a magnifying glass, evidently owing to a partial absence of the black colouring matter.

Probably the ancient vases, of superior quality, in which the red colour of the clay is so finely contrasted with the shining black of the varnish, were subjected to heat, in close vessels, as the Turkish pipe-bowls, which are of similar material, and of the same pure red colour, are baked at present: they are placed in a dome made of clay, from which the air is excluded, the fire being heaped up around.

The extraordinary durability of this varnish, as remarkable as its beauty, entitles it, I cannot but think, to consideration; and it is chiefly with the hope of calling attention to the subject, especially the attention of those engaged in our porcelain manufactories, now carried on with so much science and taste, that I venture to communicate this note to the Society.

ALEXANDER BRYSON, Esq.,

was duly elected a Fellow of the Society; and

W. H. FOX TALBOT, Esq., F.R.S.,

was elected an Honorary Fellow of the Society.

The following Donations to the Library were announced:—

The Canadian Journal of Industry, Science, and Art, conducted by the Canadian Institute. New Series, No. 12. Toronto. 8vo. —*From the Canadian Institute.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt. 1856, No. 4; 1857, No. 1. Wien, 1856–7. 8vo.—*From the Institute.*

Proceedings and Papers of the Historic Society of Lancashire and Cheshire. 1848–54. Liverpool. 8vo.—*From the Society.*

Address of Lord Wrottesley, the President, delivered at the Anniversary Meeting of the Royal Society on 30th November 1857. London, 1857. 8vo.—*From the Royal Society of London.*

Papers read at the Royal Institute of British Architects. Sessions 1855–6 and 1856–7. London. 4to.—*From the Institute.*

Return of Births, Deaths, and Marriages, registered in the eight principal towns of Scotland. November 1857.—*From the Registrar-General.*

Quarterly Journal of Agriculture, and Transactions of the Highland and Agricultural Society. January 1858.—*From the Society.*

Transactions of the Pathological Society of London. Vol. viii. London, 1857. 8vo.—*From the Society.*

Medico-Chirurgical Transactions, published by the Royal Medical and Chirurgical Society of London. Vol. xl. London, 1857. 8vo.—*From the Society.*

Monday, 18*th January* 1858.

THE RIGHT REV. BISHOP TERROT, V.P., in the Chair.

The following Communications were read:—

1. On the Mechanism of the Knee Joint. By Professor Goodsir.

After alluding to the comparatively superficial manner in which physiologists, with the exception of the brothers Weber, have hitherto investigated the structure and movements of the joints, the author gave an abstract of the general results which he had formerly obtained in an examination of the knee-joint, made with reference to Meyer's valuable observations. He had found that, as stated by Meyer, the thigh and leg rotate on one another in opposite directions,—at the close of extension, and at the commencement of flexion; and that the co-ordinated movements in the patella, the ligaments, and muscles correspond generally with the account given by that observer; but in addition he had ascertained what had previously escaped notice,

1. That the articular surfaces of the femur, tibia, and patella are not continuous but faceted surfaces.

2. That in consequence of this faceted configuration, and the peculiar manner in which the opposite articular surfaces move on one another, they are in no position of the joint congruent throughout, but gape more or less in different parts of their extent.

3. That in addition to their lubricating function, the so-called Haversian glands, or fatty folds of the synovial membrane, are arranged with reference to the resulting gaps or chinks between the opposite articular surfaces, each gap, as it opens out, being simultaneously occupied by the fatty synovial pad provided for it, and which is forced or dragged into the chink, and pulled or forced out again by special arrangements.

The author next proceeded to state, as introductory to the mechanism of the knee-joint, the results which he had latterly obtained in his examination of other diarthrodial articulations.

1. All diarthrodial surfaces are faceted, and consist of areas of distinct configuration and movement.

2. These facets and areas are marginal or terminal, and central or acting—the former giving steadiness to the action of the joint, and supplying surface on which it rests securely at the opposite ex-

tremities of its movements—the latter more especially regulating the movements themselves, and presenting the greatest extent of surface, which again consists of a moiety for each half of the movement, the one portion breaking contact, while the other is acting, and *vice versa*.

3. Even the acting facets of opposite articular surfaces are only congruent at one particular stage of their movement.

4. The movements of opposite diarthrodial surfaces upon one another appear to be in every instance a combination of gliding and rolling—the amount of the former being directly, and that of the latter inversely, as the congruence of the opposite articular surfaces.

Referring to the important simultaneous discovery recently made by Langer and Henke, and verified by Meissner, of the screwed structure of certain joints, the author proceeded to state, that he would in a future communication on the ancle and tarsal joints give the grounds on which he had come to the conclusion,

1. That in all the joints hitherto examined the screw is developed on a conical surface, and not on a cylindrical one, as is held by Langer to be generally the case.

2. That not only is it impossible accurately to prolong the screwed surface by uniting longitudinally a number of casts made from it, but that neither the original surface nor its cast admits of being screwed along the mould, with continued congruity of surface.

3. That this incongruity depends, in the first place, on the screwed surface being conical, and on the rapid increase in the obliquity of the thread; and, in the second, on its consisting of at least two areas, each being a portion of a conical screw.

After exhibiting prolonged screws, made according to Langer's method, from the upper articular surface of the astragalus in the horse, panther, lion, and human subject, the author proceeded to state, that, induced to re-examine the knee-joint from this fresh point of view, he had ascertained, in the first place, that the path described by any point in the thigh, when the leg is fixed, and the knee put through its movements, does not lie in the presumed plane of flexion and extension, as it would do if the profile curvatures of the femoral condyles were circular arcs, or logarithmic spirals, according to the ordinary view, or that of the brothers Weber; neither does the point in the upper part of its course describe the arc of a circle in a plane oblique to that in which it must afterwards move, if Meyer's observations be absolutely correct, but on the contrary describes a helix, consisting of at least two parts, an upper and a lower. This observation led the author to the detection of two screw combinations in the knee-joint; and by a careful study of the anatomical relations of the elements of the articulation he came to the following conclusions,

1. The knee-joint consists essentially of two conical screw combinations.

2. One of these screw combinations forms the anterior, the other the posterior part of the joint.

3. The axes of these screw combinations, instead of being at right angles to the so-called plane of flexion and extension, as in the ankle and elbow joints, are parallel, or nearly so, to the axis of the limb, the vertices of the fundamental cones being directed upwards.

4. The femoral condyles form the concave; the tibial condyles, intercondyloid spine, and crucial ligaments, the convex elements of each screw combination.

5. Each of these screw combinations is double-threaded; the breadth and obliquity of the threads rapidly increasing from vertex to base.

6. A comparatively limited extent of the convex element of each combination is retained, so that the larger extent of the concave element employed moves on the former by a combination of gliding in the direction of the screw, and of rolling.

7. The gliding in the direction of the screw is due partly to the screwed configuration of the opposite cartilaginous surfaces; partly to the peculiar mode of attachment of the crucial ligaments.

8. In consequence of the peculiar attachments of the successive fasciculi of the crucial ligaments, these fasciculi, after having in succession co-operated in producing the gliding movement in the direction of the screw, bend over, and thus permit the rolling movement.

9. The path described by any point in the thigh or leg during flexion or extension of the knee-joint is a helix, produced by the movements of the two screw combinations in succession: but modified by the rolling.

10. The anterior screw combination is left-handed in the right knee, and right-handed in the left.

11. The posterior screw combination is right-handed in the left knee, and left-handed in the right.

12. The two screw combinations in each knee are united, so that the anterior half of the anterior combination, and the posterior half of the posterior, are alone retained; while the external femoral and tibial condyles respectively consist of the united basal portions of one of the threads in each combination; and the inner condyloid surfaces respectively of portions of the other thread in each, but consequently towards the vertices of the fundamental cones.

13. When the knee-joint is fully extended, its anterior screw combination is screwed home, and its posterior is unscrewed; when it is completely flexed the anterior combination is unscrewed, and the posterior screwed home.

2. On the Exhibition of both Roots of a Quadratic Equation by one Series of Converging Fractions. By Edward Sang, Esq.

It had been long known that every periodic continued fraction expresses the root of a quadratic equation, and in 1808 M. Lagrange demonstrated the converse proposition, that the roots of every numerical equation of the second degree may he expressed by such fractions. The subject has since been examined by M. Legendre in his "Theorie des Nombres," and also by Barlow, and the laws discovered have been applied to the resolution of certain classes of diophantine problems of the second order.

The writers on this subject have considered the two roots of such equations separately, and have regarded the two series of fractions which converge to them as distinct. In the development of these fractions the quotients become periodic after one or more terms have been found; resembling in this way the digits of a recurring decimal fraction of which some of the earlier terms are not recurrent. The object of this notice is to show that these two series form in reality parts of one general series, the multipliers of which are periodic throughout. To this particular form of series it is proposed to give the name *duserr*, from the Persian دوشر *two heads*, or two leaders.

The character of the duserr progression was exemplified by considering the roots of the equation—

$$5x^2-32xy+31y^2=0.$$

On approximating to these roots by the known process, the quotients

$$1,5;3,1,4;3,1,4;\&c.$$

$$\text{and } 5;4;1,3;4,1,3;\&c.,$$

are found, whence the two progressions—

$$\begin{array}{cccccccc}
1 & 5\,; & 3 & 1 & 4\,; & 3 & & \\
\frac{1}{0} & \frac{1}{1} & \frac{6}{5} & \frac{19}{16} & \frac{25}{21} & \frac{119}{100} & \frac{382}{321} & \&c.
\end{array}$$

$$\begin{array}{cccccccc}
5\,; & 4 & 1 & 3\,; & 4 & 1 & & \\
\frac{1}{0} & \frac{5}{1} & \frac{21}{4} & \frac{26}{5} & \frac{99}{19} & \frac{422}{81} & \frac{521}{100} & \&c.
\end{array}$$

If, instead of proceeding forwards in either of these progressions, we compute backwards, using only the recurring quotients, we produce the other progression, thus:—

$$\begin{array}{ccccccccccccc}
 & & 3 & 1 & 4 & 3 & 1 & 4 & 3 & 1 & 4 & & \\
\&c. & \frac{-99}{-19} & \frac{26}{5} & \frac{-21}{-4} & \frac{5}{1} & \frac{-1}{0} & \frac{2}{1} & \frac{1}{1} & \frac{6}{5} & \frac{19}{16} & \frac{25}{21} & \frac{119}{100} & \&c.
\end{array}$$

The case of the roots being on different sides of the zero, was exemplified by means of the equation

$$7x^2-8xy-102y^2=0$$

which are contained in the two-headed progression—

$$\begin{array}{ccccccccccc}
 & & 7 & 2 & 3 & 7 & 2 & 3 & 7 & & \\
\&c. & \frac{171}{-52} & \frac{-23}{7} & \frac{10}{-3} & \frac{-3}{1} & \frac{1}{0} & \frac{4}{1} & \frac{9}{2} & \frac{31}{7} & \frac{226}{51} & \&c.,
\end{array}$$

and that case in which the roots lie equally on either side of the zero by the equation

$$10x^2-53y^2=0$$

the roots of which are contained in

$$\begin{array}{ccccccccccc}
 & & 4 & 3 & 3 & 4 & 3 & 3 & 4 & & \\
\&c. & \frac{99}{-43} & \frac{-23}{10} & \frac{7}{-3} & \frac{-2}{1} & \frac{1}{0} & \frac{2}{1} & \frac{7}{3} & \frac{23}{10} & \frac{99}{43} & \&c.
\end{array}$$

It was remarked that the progressions indicate certain peculiarities in these continued fractions. First, that the order of recurrence in the quotients obtained for one root is inverse of that for the other root of the quadratic; second, that in continued fractions which express the square root of any rational fraction, the order of recurrence is symmetric within each period; and third, that the last quotient of the period must be double of the first or integer part of the root.

It was also observed, that the progressions may be separated into as many progressions as there are members in the period, each progression proceeding as with a single repetend. The consideration of this branch of the subject was said to lead to the formation of series representing the impossibility of the roots when the square of the middle coefficient is less than four times the product of the extreme ones, and when these have the same sign.

The following Gentleman was duly elected a Fellow of the Society:—

Frederick Field, Esq., Chili.

The following Donations to the Library were announced:—

Scheikundige Verhandelingen en Onderzoekingen uitgegeven door G. J. Mülder. Eerste deel, derde stuk. Het Bier scheikundig beschouwd door G. J. Mülder. Rotterdam, 1857. 8vo. —*From the Author.*

Flora Batava, 182 Aflevering. Amsterdam. 4to.—*From the King of Holland.*

A Catalogue of 3735 Circumpolar Stars, observed at Redhill in the years 1854, 1855, and 1856, and reduced to mean positions for 1855·0. By Richard Christopher Carrington. London, 1857. Folio.—*From the Lords of Admiralty.*

Denkschriften der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe, Zehnter und eilfter bände.—*From the Vienna Academy.*

Annales de l'Observatoire Physique Central de Russie. Par A. T. Kupffer. Année 1854. St Petersbourg, 1856. 4to.—*From the Observatory.*

Bulletin de la Société Vaudoise des Sciences Naturelles. Tome v., No. 41. Lausanne, 1857. 8vo.—*From the Society.*

Proceedings of the Natural History Society of Dublin, for the Session 1856–57. Dublin, 1857. 8vo.—*From the Society.*

The Assurance Magazine and Journal of the Institute of Actuaries. Vol. VIII., Part 4. January 1858. 8vo.—*From the Institute of Actuaries.*

Isothermal and Rain Charts, illustrating the Climatology of the United States, and of the Temperate Latitudes of the North American Continent. By Lorin Blodget. Philadelphia, 1857. Folio.—*From Professor Henry D. Rogers.*

Monday, 1*st February* 1858.

SIR DAVID BREWSTER, V.P., in the Chair.

The following Communications were read:—

1. On the Form and Origin of the Symbols on the Ancient Sculptured Stones of Scotland. By Dr Wise.

In continuation of his former essay on the sculptured stones peculiar to the north-eastern portion of Scotland, the author produced, for the inspection of the Society, two specimens of the Buddhist *dorje*, which he considered to be the prototype of the well-known *spectacle-ornament*, found on no fewer than thirty-four of those stones; and, in twenty-nine instances, in combination with zig-zag lines, the symbol of power. The *dorje* is a portable instrument, which represents the two original members of the Buddhist Triad, spirit and matter, and is employed by the Buddhist priests of Tartary, &c., in the performance of religious worship.

The *dorjes* which were exhibited consisted each of two hollow-ribbed spheres, or ovals of brass, united by a handle, two inches long, of the same metal. When represented on the black board, with its axes or poles towards the spectator, one of the *dorjes* resembled exactly the spectacle-ornament on the larger Aberlemno stone in Forfarshire.

The *dorje* is considered indispensable to the Buddhist priest, during certain religious ceremonies. It is held over the head of the kneeling penitent in the act of absolution; and a sacred bell (likewise exhibited), having at the extremity of its handle a ball similar to those of the *dorje*, is rung. In some temples direct worship is paid to a *drje* kept for that purpose.

It is well known that the Buddhist priests were enjoined to spread themselves over the world for the propagation of their faith, and that they speedily overran, and converted, a large portion of the great nations of Asia. As they are proved to have been known in Europe, during the second and fifth centuries, it appears probable that they may have reached Scotland by means of Phœnician ships. In this case they would introduce the *dorje*,—the indispensable symbol of their faith,—and would naturally incise the figure of it upon the upright stones, possibly erected at an earlier period, as objects of veneration: And in such representations, as the priest was not present to complete the sacred symbolism of the Buddhist faith, by representing the third member of the Triad, or organized matter, the result of the interaction of the two former members, this was represented by the figure of an elephant, or a bird, or the segment of a circle, well-known as the *cockit-hat-ornament*, &c.

Various instances were given, in which the Buddhists borrowed religious ceremonies from the ritual of the Latin Church. A similar combination appears to have taken place in Scotland, on the introduction of Christianity; with this difference, that there the faith and the symbol of the cross eventually prevailed over those of Buddhism. For a time, however, the old symbol of the deity, the *spectacle-ornament*, or, as it ought in the author's opinion to be styled, the *dorje symbol*, was retained along with the emblems of Christianity. From the similarity to each other, of the figures on the sculptured stones of the north-eastern part of Scotland, they appear to have been executed by the same Christian community, and that the very earliest in that part of the island; the community, in fact, to which Tertullian refers, in the third century, as inhabiting those parts of Britain never conquered by the Romans, and which, after gradually superseding the more ancient belief, flourished in the great kingdom of the Picts.

2. Notes on the Structure of Amphora, a genus of Diatomaceæ, and the diagnosis of its species. By Dr Walker Arnott.

When Linnæus said that all objects of natural history must have a *specific name*, he did not mean a *trivial* name (which was not then invented), but what is called a short, distinctive character, otherwise it is not imperative on others to adopt the trivial name imposed, or recognise it in any way. The want of short characters (intended to place clearly before the mind the few essential points of difference between supposed new and already known forms or species) cannot be supplied by figures or diffuse descriptions of the entire object, as these leave quite in the dark the precise *marks of distinction* observed by the writer, if such actually existed. In composing either a defining character or a detailed description, it is also necessary to use the technical language of that science. The author, in referring to Dr Gregory's paper on the Diatomaceæ of the Clyde, published in the last part of the *Transactions*, regretted that this patient observer had neglected these rules, and thus enveloped his whole memoir in an almost impenetrable cloud; thus not only precluding himself from claiming any right of priority of names, in the event of the same form being afterwards correctly characterized by another under a different name, but depriving the paper itself of its claims to be considered a scientific one. The same unfortunate cloud rendered it difficult to understand what Dr Gregory's actual views of the structure of Amphora were; although, from expressions used by him, he appears to enunciate the theory, that what other writers call a simple frustule, ought to be considered as a double one.

The author, to make this more intelligible to those not generally interested in such pursuits, defined what the structure of a diatom was, as is explained by Smith in his Synopsis of British Diatomaceæ; and indicated the mode of proving, by Canada balsam, whether the frustule was single or double. When tested in this way, what was *commonly* called a simple frustule was found to be actually so, and of one cell, so that Dr Gregory's hypothesis was untenable. The structure of the genus Amphora appears to have been also slightly misunderstood by Kutzing and Smith. The real form of the frustule is not a spheroid, as they must have considered it, but rather like that of a coffee-bean, rounded at the back and hollowed out in front, the line connecting the two terminal and central nodules of each valve being the median line; this line and the central nodule are thus not marginal, as hitherto described, but exactly as in other diatoms in which such are found. An Amphora would thus chiefly differ, by the half of the valve on the one side of the median line being concave, while the other was convex; whereas, in most genera of the group the two halves of the valve are precisely alike.

The form and structure of the frustule being established, the parts capable of affording good distinctive marks for species were next examined. All naturalists agree, that if these are taken from variable parts, they must be of less importance than if derived from those that are subject to little or no variation; and that no observation can be relied on, of a permanent kind, when taken from parts known to change their appearance rapidly. Thus, the zone connecting the two valves of a diatom, which, from being a mere line, is understood to attain the whole breadth of the frustule in the course of twenty-four hours, has been deservedly rejected; and hence it is to be feared that few or none of Dr Gregory's species of "Complex Amphoræ," which owe their peculiar appearance to it, will stand the test of diagnostic characters. As the striæ, costæ, or furrows, are the same on both sides of the median line, and as the valve is folded, those at the back of the frustule must be seen through the medium of the surface nearer the eye, and crossing those belonging to it, so that observations on these relate entirely to the *accidental* position the frustule happens to be in. This compels one to depend chiefly for essential characters—1st, on the small portion that is seen between the median line and the apparent outline of the frustule; and 2d, on the form of the frustule itself, *previous* to the siliceous connecting zone commencing the process of self-division.

The author also stated his conviction that no certain conclusions could be drawn as to what was a new form or species from deposits or dredgings, on account of the impossibility of procuring the species in an isolated state, and consequently of studying them independently; the same species putting on very different aspects, and different species assuming the same aspect at particular stages of self-division.

Microscopical differences are by themselves of little importance. To see is one thing, to understand and combine what we see, another: the eye must be subservient to the mind. Every supposed new species requires to be separated from its allies, and then subjected to a series of careful observations and critical comparisons. To indicate *many apparently* new species is the work of an hour, to *establish* only *one* on a sure foundation is sometimes the labour of months or years. In microscopical natural history as much scrutiny is required to prove a new form to be distinct from its allies as in chemistry to discover a new alkaloid, or in astronomy to demonstrate the identity of two comets. A naturalist cannot be too cautious. It is better to allow diatoms to remain in the depths of the sea, or in their native pools, than, *from imperfect materials*, to elevate them to the rank of distinct species, and encumber our catalogue with a load of new names so ill defined, if defined at all, that others are unable to recognise them; the same object can be more easily attained by attaching them, in the mean time, to some already recorded species, with the specific character of which they sufficiently accord. In all such cases the question to be solved for the advantage of naturalists is not, whether the object noticed be a new species, but whether it has been proved such, and clearly characterized.

The following Candidates were duly elected Fellows of the Society:—

James Leslie, Esq., C.E.
Cosmo Innes, Esq., Advocate.
Professor A. C. Fraser.

The following Donations to the Library were announced:—

Proceedings of the Royal Society, London. Vol. IX., No. 28. London. 8vo.—*From the Society.*

Proceedings and Papers of the Historic Society of Lancashire and Cheshire. Sessions 1 to 6. Liverpool, 1849–54. 8vo.—*From the Society.*

Papers read at the Royal Institute of British Architects. Sessions 1855–56 and 1856–57. London, 1856–7. 4to.

The Canadian Journal of Industry, Science, and Art. November 1857. Toronto. 8vo.—*From the Institute.*

Atlantis: A Register of Literature and Science. Conducted by Members of the Catholic University of Ireland. No. 1. January, 1858. London. 8vo.—*From the Editors.*

Œuvres Complètes de N. H. Abel, Mathématicien, avec des notes et développements. Rédigées par B. Holmboe. 2 Tomes. Christiania, 1839. 4to.—*From the University, Christiania.*

Quelques Observations de Morphologie Végétale faites au Jardin Botanique de Christiania, par J. M. Norman. Christiania, 1857. 4to.—*From M. Norman.*

Inversos vessicæ urinariæ og lüxationes femorum congenitæ hos samme Individ, iagttagne af Lektor Voss. Christiania, 1857. 4to.—*From the University, Christiania.*

Observations sur les Phénomènes d'Erosion en Norvège, recueillies par J. C. Hörbye. Christiania, 1857. 4to.—*From the University, Christiania.*

Bemerkungen über den mechanischen Bau der Baumwoll-Faser, von Gilbert J. French. Hanover, 1857. 8vo.—*From G. Lawson, Ph. D.*

Journal of the Asiatic Society of Bengal, 1857, No. 4. Calcutta, 1857. 8vo.—*From the Society.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt, 1856, No. 4; 1857, No. 1. Wien. 8vo.—*From the Vienna Institute.*

Nyt Magazin for Naturvidenskaberne Binds I.—IX. Christiania, 1842. 8vo.—*From the University, Christiania.*

Astronomical Observations made at the Observatory of Cambridge, by the Rev. James Challis. Vol. XVIII., for the years 1849, 1850, and 1851. Cambridge, 1857. 4to.—*From the Syndicate of the Cambridge Observatory.*

Bulletin de la Société Vaudoise des Sciences Naturelles. Nos. 34–40. Lausanne, 1854–7. 8vo.—*From the Society.*

Address of Thomas Bell, F.L.S., President to the Linnean Society, London, May 25, 1857. London, 1857. 8vo.—*From the Society.*

Ueber die Geologie des Südlichen Norwegens von Theodor Kjerulf, mit Beiträgen von Tellef Dahll. Christiania, 1857. 8vo.

Lehrbuch der Mechanik von Dr P. J. Broch. Christiania, 1854. 8vo.

Beitrage zur Lateinsischen Grammatik, I. Von L. C. M. Aubert. Christiania, 1856. 8vo.

Monday, 15th February 1858.

MR JAMES T. GIBSON-CRAIG, Treasurer, in the Chair.

The following Communications were read:—

1. Description of the Sulphur Mine near Conil; preceded by a Notice of the Geological features of the southern portion of Andalucia. By Dr Traill.

Dr Traill's paper was divided into four sections: the 1st contained the geology of Andalucia from the Sierra Nevada of Granada to the south; the 2d described the mountain or rock of Gibraltar; the 3d traced the succession of rocks from the Sierra Morena to the south and south-west; and the 4th described the Sulphur Mine near Conil.

1. In the part of the Sierra Nevada visited by Dr Traill, which was at about two-thirds of its height, the only visible rocks were mica-slate, in its lower portions approaching to gneiss, on which reposed beds of limestone, evidently belonging to the same formation as the slate. These rocks, too, form the mountain ranges south of Granada, towards the shores of the Mediterranean, near Velez-Malaga, where they are covered by a very shining clay-slate without organic remains; and which, in the Sierras Mijas and Bermeja, often contain beds of white statuary marble.

The clay-slate continues along the coast to the south of Malaga and Marbella; but at the Rio Verde it gives place to Old Red Sandstone, or *Devonian* strata; while the rugged mountains to the west appear to consist of primary rocks. This *Devonian* sandstone is the fundamental rock of the Sierra Carbonera, the nearest range to Gibraltar, and around the bay of that fortress. On this appears to repose a limestone, which the author referred to the mountain limestone. On going westwards from Granada by Loja, Archidona, and Antequera, the mountains seem to consist of limestone like that of the Sierra Nevada. But on reaching the valley of Teba, he found newer rocks, viz., a limestone containing shells, on which reposed beds of gypsum and a reddish clay. In this valley is a salt lake, evaporated for culinary salt; and the gypsum often contained crystals of rhomb-spar. This valley he therefore considered as belonging to the Mágnesian Limestone and New Red formations, or *Permian* system of Sir Roderick Murchison. Farther to the south, as about Ronda and Guarroman, a gritty limestone occurs in which he found ostracites and other marine shells; and in the valley of Alhama, in Granada, similar limestone occurs, with those shells, mytilites and corals. Both formations he refers to the *Oolite* system.

2. The author described the geology of Gibraltar, which he referred entirely to the true mountain limestone, and illustrated his remarks by specimens of the solid rock, of the fibrous limestone, and of the calc-sinter deposits containing bones.

3. The author then traced the different rock formations from the Sierra Morena to the south and south-west.

In this Sierra he found in the upper regions gray and red granite, the latter often containing crystals of andalucite; and syenite also occurs in some places. These rocks are generally covered by a very shining mica-slate; but in descending towards the south, this is succeeded by clay-slate. At S$^{ta.}$ Elena this slate contains many crystals of chiastolite, exactly like that of Cumberland. A little south of S$^{ta.}$ Elena he found true grauwacke and grauwacke slate, or unmistakeable *Silurian* formations; on which reposed oolitic limestone, containing ostracites, and other shells.

The Oolite occurs in other parts of Andalucia, as already noticed; and it forms extensive tracks between Tarifa and Conil.

Still newer formations begin in the valley of the Guadalquivir, and in the country between Sevilla and Xeres. At Lebrija are hills of indurated chalk, containing flint. Tertiary formations occur between Cadiz and Gibraltar, as well as in other valleys of this province; so that Andalucia presents formations belonging to all the great geological epochs.

4. The Sulphur Mine lies near the sea, about three miles east of Conil. It occupies a small oval valley surrounded by oolitic rocks, and is filled with a bluish marl, the matrix of the sulphur. The sulphur is often finely crystallized in its cavities, and is accompanied by crystals of sulphate of lime and calc-spar. The mine was wrought until about the time of the French invasion of Spain. In 1814 it was not wrought; but this seemed less from exhaustion of the sulphur, than from the troubles of the Peninsula, and the want of fuel to sublime the sulphur. Magnificent crystals of this sulphur are in the royal cabinet at Madrid.

The author concluded by some speculations on the origin of the sulphur in the Mine of Conil.

2. Remarks on a Slab of Sandstone containing numerous Cavities, apparently produced by Marine Animals. By Charles Maclaren, Esq.

This slab was found lying on the sand about 150 yards within high-water mark, a little northward of the projecting headland called Whitberry Point, on the coast of East Lothian. The headland is of trap, which rests on a red sandstone, similar to that of the slab. The sandstone covers some acres northward of the headland at low water, running out in a succession of ridges in a north-east direction, and dipping to the south-east. The slab is of a triangular form; its length is 17 inches, greatest breadth 9, and the thickness varies from 1½ to 2 inches. It rested on the sand, with the honeycombed face undermost, without any other fragments near it, and 20 yards, or more, from the nearest sandstone *in situ*. On one side it is dimpled with twenty-three round cavities, all cup-shaped. A few are so faint as to present merely slight markings; the others are from 1 inch to 1½ inch in diameter, and from ⅛ to ⅜ an inch in depth, with rounded edges. The cavities shew a tendency to a linear arrangement; those in one line having their sides in contact, or nearly so; and the whole are in two groups, the cavities in each crowded together, and no one cavity standing entirely detached. The opposite side of the slab has no cavities, and is thinly covered with some species of vegetation, apparently a lichen; but there are four or five small vestiges of cavities, and two large ones on the edge of the slab. In explanation of the cavities, it was stated that there are many marine animals which bore holes in stones to make lodgments for themselves, such as those described in Forbes and Hanley's "British Mollusca," and in Doctor Johnston's "Conchology," under the titles of Pholas, Saxicava, Petricola; and in the English Cyclopædia, under that of "Lithophagidæ," including also the Patella and Echinus. These animals burrow in wood, chalk, limestones, shale, and some of them in red sandstone. Reference was also made to Dr Johnston's work (Letter 10th) to show that the property of burrowing in stone had been attributed to some terrestrial mollusks (the "Helix nemoralis," and "Helix aspersa"), by Dr Buckland, and others, though not on very certain grounds. Allusion was also made to the mode in which the Helixes named "cluster together" on the under surface of stones or ledges of rock, as presenting an analogy with the clustered or grouped disposition of the cavities, on what appears to be the "lower surface" of the slab, as indicated by the absence there of the vegetation seen on the opposite surface. The slab had evidently been moved from its original site, probably by the action of the waves in a storm. He inclined to the opinion, that the cavities were made by animals like the Patella, which bore holes to a moderate depth, and being perhaps gregarious in their habits. Four opinions had been proposed as to the process by which the mollusks excavate the holes, and are discussed by Forbes and Hanley:—1. By rasping the rock with the sharp edge of the shell; 2. By dissolving the rock with an acid secreted by the animal; 3. By grinding with silicious particles attached to some part of its body; 4. By vibratory cilia set in motion by the animal, and producing currents of water. But objections have been made to all these opinions.

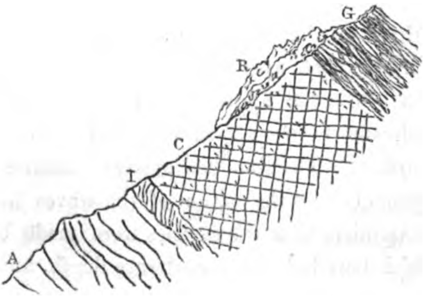
3. Notice respecting some Artificial Sections illustrating the Geology of Chamouni. By John Ruskin, Esq. Communicated in a letter to Professor Forbes.

In the Proceedings of the Royal Society, vol. iii., p. 348, an account has been given by Professor Forbes of the discussions which had then taken place as to the geological constitution of the chain of Mont Blanc, and as to the reality of the alleged superposition of the primary rock (gneiss) to the secondary (limestone), near Chamouni, and at Courmayeur.

In order to clear up any remaining doubt, Mr Ruskin caused sections to be made, laying bare the junction at several points of the Valley of Chamouni. The results, which are perfectly accordant with the conclusions of the above-cited paper, have been kindly communicated by Mr Ruskin to Professor Forbes, and are described and sketched by him in the following note. The order of the sections is from the head of the Valley of Chamouni towards its lower or south-western extremity.

Specimens of the more important rocks have been placed in the Museum of the Royal Society:—

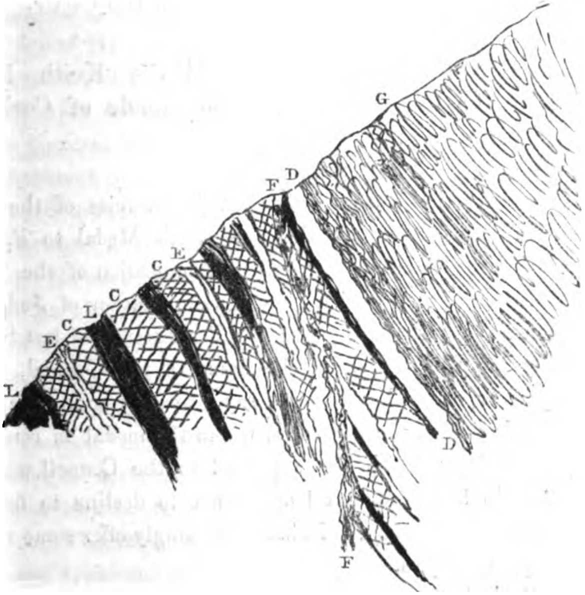
" 1. At Crozzet de Lavanchi, on road to Argentiere, under the Aiguille de Bochard.



- " A. Black calcareous rocks of the Buet, with belemnites, a good deal contorted (the same rock as at Côte des Pigets).
- " I. Imperfect cargneule (porous limestone), about 2 feet thick.
- " C. Common cargneule, used for limeworks, &c. (about 50 feet thick at the utmost).
- " R. Debris concealing junction with gneiss.
- " G. Gneiss laid bare, striking N. 50 E., and dipping 36° S.E., an unusually small angle, quite accidental and local, the average dip south being much steeper.

" 2. On the road to Chapeau, the same succession of beds takes place, the dip being greater (about 50°); the Buet limestones lower down dipping still more (about 65°). I say 'about,' not as guessing the angle, but giving the average of many accurate measurements.

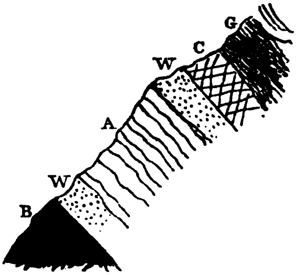
" 3. Junction opposite Prieuré of Chamouni, at my excavation.



- " L. Brown limestone, a form of the cargneule.
- " C. Cargneule, generally enclosing fragments of the browner limestone, and with bands of greasy green earth, E, E, in the middle of its beds.
- " F. Fault filled with fragments of clay and cargneule.
- " D. Decomposing white gneiss.
- " G. Hard gray gneiss of Montanvert.

"4. At Les Ouches, in the ravine under the Aiguille du Gouté.

"B. Black slates of the Buet.
"W. Pure white fine-grained gypsum.
"A. Buet limestone (A of first section).
"W. Gypsum.
"C. Cargneule (C of first section).
"G. Gneiss.



Monday, 1*st March* 1858.

Professor KELLAND, V.P., in the Chair.

Professor Kelland, V.P., delivered the Keith Medal, awarded by the Council to Professor Boole of Cork; on doing which he said:—

The Council of the Royal Society, in the exercise of the power conferred on them, have awarded the Keith Medal to Professor Boole of Cork, for his Memoir "On the Application of the Theory of Probabilities to the Question of the Combination of Judgments or Testimonies," printed in the Society's Transactions of last Session.

In conferring this medal, in the name of the Council, it may reasonably be expected that I should say a few words on each of two different heads—*first*, the person on whom the medal is conferred; *secondly*, the paper, which has appeared to the Council worthy of the award. And I admit that I ought not to decline to fulfil the expectation after some sort. I shall accordingly offer some remarks on these separate topics.

1. Mr Boole is a stranger to us; in no way connected with Scotland, further than as a similarity of pursuits connects one intellect with another. To Bishop Terrot alone amongst us, who is labouring successfully in the same department of science with himself, is he, so far as I am aware, personally known. I will therefore endeavour to sketch Mr Boole's past history, that you may have the

materials for inferring the amount of confidence to be placed in the researches which we have selected for honour.

Mr Boole is one of those remarkable men who, under almost every possible disadvantage, rises from obscurity to high eminence. In early youth he held the situation of usher in a school in Yorkshire. After four or five years thus spent, he commenced business as a schoolmaster, on his own account, in the city of Lincoln, being even then under twenty. He was not unsuccessful. This is a remarkable fact, when we consider that he delighted in such reading as the "*Mécanique Céleste,*" and "*Liouville's & Crelle's Journals.*" That such was his reading is abundantly proved by his earlier papers—the first of which appeared, so far as I know, in the "Cambridge Mathematical Journal for 1840." These papers attracted the attention of the editor of the Journal, Mr Gregory, and a correspondence had commenced between them, which the lamented death of the latter alone prevented being productive of much valuable fruit. My first knowledge of Mr Boole, except such as might be derived from the papers above referred to, commenced in 1844, about the beginning of which year he sent to the Royal Society of London a Memoir "On a General Method in Analysis." Many problems of no very great apparent complication had baffled the ingenuity of mathematicians. Solutions were, it is true, obtained, but the processes were so indirect and unsatisfactory, that they were something like excrescences on the smooth face of science. Of this class of problems is an equation which occurs in the theory of the figure of the earth. Mr Airy, in his "Tracts," gives simply the result, without the slightest indication of a process. Mr Gaskin and Mr Leslie Ellis had attacked this individual problem with partial success. But Mr Boole's "New Method" not only set the logical question of dealing with separation of symbols in a clear light, but completely effected the solution of all that class of problems, of which this was a particular example. The Royal Society did me the honour to refer the paper to me, and I had the good fortune at once to perceive its importance, and to recommend the Society to bestow on it a mark of approbation. Accordingly, the Council of the Society awarded to Mr Boole the Royal Medal for 1844, expressing their conviction that "his Method would find a permanent place in the science."

After this he remained many years in comparative obscurity in Lincoln, but at length received the appointment of Professor of Mathematics in Queen's College Cork, which he still holds. He commenced his career as professor somewhat daringly, by publishing in succession,—1*st*, "A Lecture on the Claims of Science," in which he advances out of his subject into the domain of mental philosophy. 2*d*, "An Investigation of the Laws of Thought." This last volume, which is equally remarkable for clearness of enunciation, breadth of generalization, and originality, of thought, is the prelude to the paper for which we this day present Mr Boole with the Keith Medal. Mr Leslie Ellis has pointed out in the first volume of the collected works of Bacon, that some of the germs of Mr Boole's ideas are to be found in the writings of that great philosopher, and in those of Leibnitz. But this, instead of detracting from the claims of Mr Boole, is rather a proof of his power, or at any rate of his sagacity in seizing on and developing ideas which lay unexpanded in the records of minds so vast and so original.

This is all I shall say about the *person* on whom the Keith Medal is to be conferred.

2. Let me now very briefly refer to the *paper* for which this award has been made. The problems which the author proposes to solve are these :—1*st*, That of combining testimonies whose different values may be regarded as numerical measures of a physical magnitude. 2*d*, The same problem in which the testimonies are not only expressible, as in the former, but relate to some fact or hypothesis of which it is sought to determine the probability. Relative to the former of these, an important element, now, I believe, first completely discussed, is the determination of the " Conditions of Possible Experience." Suppose, for example, it were asserted that of all cases of a certain disease, two-fifths of the patients were affected with shivering and sweating, two-thirds with shivering and thirst, and four-fifths with sweating and thirst, this very assertion would be found to contain within itself the elements of its own condemnation, seeing that it violates the conditions of possibility.

The other problem has for its object, to combine the force of two testimonies in support of a fact, the strength of each separate testimony being given. That a complete discussion of this problem is most valuable in itself cannot be doubted. What has here been written may rather be regarded as material for a future judgment than as exhausting the consideration of the question. There are so many conditions to be taken into account, and such a tendency exists in writers to adopt one general standard of reference, that a critical examination like the present, which certainly does much towards throwing down the buildings of others, cannot fail to have great value, even should its own foundations not stand. This is not like a discovery in pure analysis,—the opening up of a royal road from one position to another,—so much as a survey of the ground, with a view to the assertion that the right road lies on this side, and not on that, of some given obstacle. In the name of the Council, I beg our Vice-President, Bishop Terrot, to take charge of this Medal for Professor Boole, and to express to him our wishes for his future success in the career to which he has devoted himself. Bishop Terrot is not, in this instance, a mere passive spectator, nor a mere hand to convey a reward from one party to another; he stands in the light of a participator in the honour, and that to no small extent. The problem of combining two or more probabilities of the same event received from Bishop Terrot a solution in our Transactions two years since, to which the present paper is probably due. Here, for the first time, was given the form of the probability or value of expectation due to *entire ignorance*, as an indeterminate fraction. This result, as indeed the other conclusions of Bishop Terrot, the present paper satisfactorily confirms. Bishop Terrot, therefore, whilst I doubt not he will cheerfully transfer the award to Mr Boole, will still retain a share in the honour.

The following Communications were then read :—

1. On the Average Value of Human Testimony. By Bishop Terrot.

The author began by some remarks upon the expression $\frac{pv}{pv+(1-p).(1-v)}$ or $\frac{pv}{pv+wq}=\text{U}$. Where p represents the *a priori* probability of an event attested by a witness whose veracity, or the ratio of whose true assertions to the number of all his assertions is, v. He observed that U, or the ultimate probability of the asserted fact, depended upon the accuracy of the numerical value given to v, and that men have never such knowledge of their neighbours' antecedents, as to assume this value with anything like an approximation to the truth.

It was then suggested that a more definite result might be obtained, by assuming, from experience, the value of U, and thence determining the value of v. The instance adopted was that of a man saying that out of a bag containing 99 white balls and one black, he has at the first trial drawn the black. In such a case, so long as there exists in our minds no suspicion of a motive for falsehood, the assertion is absolutely believed; that is to say, we give to U the value unity. But p being the proper fraction $\frac{1}{100}$, U cannot equal 1 unless $v=1$; that is to say, unless we consider human testimony, even to improbable events, as certainly truthful, in every case where there exists no suspicion of the action of a motive for falsehood. The suspicion of such motive at once prevents us from giving to U the value 1; that is, from receiving the assertion as absolutely true. If, for example, the man who drew the black ball was to gain L.1000 by our being persuaded that he had done so, we should not readily take his word for the fact that he had so succeeded.

It was then noticed that the expression for the ultimate probability given by Laplace was

$$\frac{vr+(1-v).(1-r)}{vr+(1-v).(1-r)+\left[v.(1-r)\times r(1-v)\right]\frac{1-p}{p}},$$

where r represents the probability that the witness, though intending to tell the truth, deceives himself. If in this expression 1 be substituted for (r) this formula coincides with $\frac{pv}{pv+(1-p).1-v}$, for all the cases treated in the paper are cases where there can be no reasonable suspicion that the witness is deceived. It was at the same time allowed that there are numerous cases where a suspicion of this, or some other disturbing force, may reasonably be suspected. But it was maintained that such cases, however numerous, are *exceptional*, and are very few compared with those to which no suspicion attaches: and that were this not the case, human testimony would be of no practical value, and human society could not subsist. The final inference was, that habitual credulity is less unreasonable than habitual incredulity; that in the former the exception is sacrificed to the rule, in the latter the rule is sacrificed to the exception.

2. On the Tides in the Sound of Harris. By Henry C. Otter, Esq., R.N., Captain H.M.S. "Porcupine." Communicated by Dr Stark.

The author stated that during summer, in neap tides, the stream flows from the Atlantic into the Minch all day, but from the Minch into the Atlantic all night. In winter this was reversed, the stream flowing through the Sound of Harris from the Minch into the Atlantic all day, but from the Atlantic into the Minch all night.

In spring tides, both during summer and winter, the stream comes in from the Atlantic during the greater part of the time the water is rising, and flows back into the Atlantic during the greater portion of the fall of the tide.

The rise and fall of the tide was found to be much more influenced by the direction and force of the wind than by the moon's parallax. Thus, a strong southerly or south-west wind raised the water to equinoctial height, but produced a very poor ebb. The velocity of the current through the Sound of Harris was stated to be about five miles an hour during spring tides, but only from two to two and a-half miles an hour during neap tides.

Various other interesting particulars were mentioned relative to the local peculiarities of the tides in the "Narrows of Berneray," at the "Hermetray Group," and at the "Groay Group," and a diagram was exhibited, by means of which the time of high water and low water could be easily found in the Sound of Harris, on knowing the moon's meridian passage.

Dr Stark, who communicated the paper, appended a note, endeavouring to account for the peculiarity in the current through the Sound of Harris, attributing it to a difference in the level of the water in the Atlantic and the Minch, caused by the attraction of the sun. So long as the sun was north of the equator, and its attractive power was greatest over the North Atlantic, the level of the Atlantic during the day would probably be found to be higher than that of the water in the Minch, so that during all the day the current would run from the Atlantic into the Minch; during night, when the attractive power of the sun was removed from the North Atlantic, its level would fall, so that the stream would flow from the Minch into the Atlantic. In *winter*, when the sun was south of the equator, its attractive power being exerted during the day on the South Atlantic, the level of the North Atlantic would be lowered; so that, *during the day*, the stream would flow from the Minch into the Atlantic. *During the night*, from the removal of the sun's attraction over the South Atlantic, the North Atlantic would regain its level; so that during the night, in winter, the stream would flow from the Atlantic into the Minch.

The following Donations to the Library were announced:—

Quarterly Return of the Births, Deaths, and Marriages registered in the Divisions, Counties, and Districts of Scotland. Quarter ending 31st December 1857.—*From the Registrar-General.*

Journal of Agriculture and Transactions of the Highland and Agricultural Society of Scotland. March 1858.—*From the Society.*

Documents and Proceedings connected with the Donation of a Free Public Library and Museum by William Brown, M.P., to the Town of Liverpool. Liverpool, 1858. 8vo.—*From Dr Hume.*

Philosophical Transactions of the Royal Society of London for the year 1857. Vol. CLXVII., Part II. London. 1858. 4to. —*From the Royal Society of London.*

List of the Royal Society of London, 1857.—*From the Society.*

Six Discourses delivered before the Royal Society, &c. By Sir Humphrey Davy, Bart. London. 1827. 4to.—*From the Society.*

Report on the Adjudication of the Copley, Rumford, and Royal Medals, &c. London. 1834. 4to.—*From the Royal Society of London.*

Portugaliæ Monumenta Historica, a sæculo octavo post Christum usque ad quintumdecimum, jussu Academiæ Scientiarum Olisiponensis edita. Leges et Consuetudines, volumen I. fasc. 1. Scriptores, volumen I. fasc. 1. Olisipone. 1856.—*From the Royal Academy, Lisbon.*

Memorias da Academia R. das Sciencias de Lisboa, 2ª serie, tom. I, II, III. Do. Nova serie 1ª e 2ª classe, tom. I., pt 1 e 2; 2 pt 2.—*From the same Academy.*

The Canadian Journal of Industry, Science, and Art. January 1858.—*From the Canadian Institute.*

Almanaque Nautico para el ano 1859. Calculado de Órden de S. M. en el Observatorio de Marina de la Ciudad de S. Fernando. Cadiz. 1857.—*From the Observatory, St Fernando.*

Sulle forme cristalline del Boro Adamantino, per Quintino Sella. Torina. 1857. 4to.—*From the Author.*

Sulle forme cristalline di Alcuni sali de Platino e del Boro Adamantino, per Quintino Sella. Torino. 1857. 4to.—*From the Author.*

Translation from Dutch Pamphlets on Herring Fisheries. 1857. (Board of Trade). London. 1858. 8vo.—*From Dr Stark.*

Proceedings of the Royal Astronomical Society. Vol. XVIII. No. 3.—*From the Society.*

Quarterly Journal of the Chemical Society. No. 40.—*From the Society.*

Collecção de Noticias para a Historia e Geografia das Nações Ultramarinas, que vivem nos dominios Portuguezes ou Lhes São Visihhas; publicada pela Academia Real das Sciencias. Tom. V., VI., VII. Lisboa. 1836–56. 8vo.—*From the Royal Academy of Lisbon.*

Viagens extensas e dilatadas do celebre Arabe Abu-Abdallah, mais conhecido pelo nome de Ben-Batuta. Traduzidas por Jose de Santo Antonio Moura. Tomo II. Lisboa. 1855. 8vo.—*From the same Academy.*

Annales das Sciencias e Lettras, publicados debaixo dos auspicios da Academia Real das Sciencias. 1ª Classe, Sciencias, Mathematicas, Physicas, Historico-Naturaes, e Medicas, tomo I. Marco–Septembro, 1857. 2ª Classe, Sciencias, Moraes, e Politicas, e Bellas Lettras, tome I. Marco–Julho, 1857.—*From the same Academy.*

Transactions of the Linnean Society of London. Vol. XXII., Part 2. London. 1857. 4to.—*From the Society.*

Monday, 15*th March* 1858.

The Right Rev. Bishop TERROT, V.P., in the Chair.

The following Communications were read:—

1. Note on the use of Subacetate of Lead as a means of separating some of the Vegetable Alkaloids. By Thomas Anderson, M.D., F.R.S.E.

In a paper on the crystalline constituents of opium, read before the Royal Society of Edinburgh, I described a process for separating thebaine from papaverine and narcotine, with which it occurs mixed in the opium liquor I examined. This process consisted in converting the mixed bases into acetates, and adding to the solution an excess of subacetate of lead, by which the feebler bases are precipitated, and the stronger thebaine left in solution.

As it is familiarly known that in those plants in which alkaloids are found, they rarely occur singly, but are generally associated in groups of two or more, often very closely allied in their properties, and consequently require for their separation, processes of considerable complexity, I have been induced to make a few experiments, with the view of ascertaining whether the method I had applied with success to the opium bases could be used for other substances. These observations I offer, not as exhausting the subject, but merely as an indication of a path which may be followed by those engaged in the examination of the natural bases with some prospect of success.

When a dilute solution of acetate of strychnine, containing an excess of acid, is mixed with a saturated solution of subacetate of lead, until its reaction becomes alkaline, and a further quantity of the lead-salt added, the fluid at first remains perfectly clear; but after some time minute crystals of strychnine begin to be deposited, and go on gradually increasing in quantity for four-and-twenty hours. If the solution be highly diluted, the strychnine is deposited slowly, and then appears in very regular crystals, occasionally of considerable size. Concentrated solutions, if violently agitated, are rapidly filled with precipitated strychnine.

If brucine be treated in a similar manner, the solution remains perfectly clear, and, even where violently agitated, no precipitate makes its appearance. At the end of twenty-four hours, the fluid is still clear, although I have once or twice, when the solution was concentrated, observed a few needle-shaped crystals of the base at the bottom of the fluid.

Acetate of cinchonine, in moderately diluted solution, begins to deposit small crystals of the base almost immediately after the subacetate is added, and the quantity goes on increasing for some hours. Agitation produces an immediate précipitate.

Quinine is not deposited from its acetate, even on standing during the night, provided the solution be dilute; but if concentrated and briskly shaken, small tufts are occasionally thrown down after standing for some hours.

Morphine and thebaine are not thrown down from solutions of their acetates, even after standing; and codeine, as might be anticipated from its solubility in water, is entirely unaffected. On the other hand, narcotine, papaverine, and narcine are instantaneously precipitated as bulky powders.

These facts indicate the importance of a more minute attention being paid to the deportment of the vegetable alkaloids with subacetate of lead. We observe that in the case of the two cinchona and the two nux vomica alkaloids, the difference is very marked, and the reaction might be used as a means of separation, and possibly also of purification. Most of the substances found in vegetable extracts, such as gum, &c., are precipitated by subacetate of lead; and in the case of the stronger bases, it might be possible to effect purification by extracting with acetic acid, and precipitating with the subacetate. The strong base would then remain in solution along with excess of lead, which being precipitated with sulphuretted hydrogen, would carry down colouring matters, and leave a pure acetate in solution. I have not attempted to put this process into practice, but recommend a trial of it to those chemists who are engaged with the examination of the natural alkaloids.

2. On the Colouring Matter of Persian Berries. By Mr John Gellatly, assistant to Dr Anderson, Glasgow.

Two varieties of the seeds of the *Rhamnus tinctoria* are found in commerce, known by the names of Persian and Turkish berries. The former are said to be gathered before being fully ripe, and are carefully preserved; the latter have remained much longer on the branches, and are brown and shrivelled. Kane has examined both varieties, and finds in the former a substance which he names Chrysorhamnine, soluble in alcohol and ether, and crystallizing from the latter in minute silky needles of a brilliant yellow colour. This substance is replaced in the ripe berry by another, which he names Xanthorhamnine, of a much less beautiful yellow, and not crystallizable; this change is effected also by boiling the chrysorhamnine for a few minutes with water. Xanthorhamnine is easily soluble in alcohol and water, but quite insoluble in ether.

The Persian berries which the author examined yielded to ether no chrysorhamnine, but with alcohol they gave a considerable quantity of a pale yellow substance in fine crystals, which was believed to be Kane's xanthorhamnine, although that chemist did not obtain it crystalline.

It is prepared by digesting the coarsely-ground berries for a short time with boiling methylated spirit, filtering and expressing the residue. The fluid is left for several days, to deposit a dark-coloured resin, and then poured off and set aside. In about ten days, it is converted into a yellow semi-solid mass. This is pressed and recrystallized several times from alcohol; when nearly pure, the crystals appear as the solution cools.

Xanthorhamnine appears in tufts of dense silky needles, of a pale yellow colour, and nearly tasteless. Readily soluble in cold and warm water. It dissolves also in alcohol, and very readily when hot. It is quite insoluble even in boiling ether. The analysis of three separate preparations, dried at 212°, gave results somewhat different from Kane's; and, guided by the products of decomposition detailed in the paper, the author proposes for the substance the formula $C_{46} H_{28} O_{28}$, which agrees with his experiments, as shown by the subjoined comparison—

Carbon	52·43	52·24	51·82	51·91	52·27	C_{46}	276
Hydrogen	5·85	5·58	5·74	5·95	5·30	H_{28}	28
Oxygen	...	...	...	...	42·43	O_{28}	224
					100·00		528

The air-dried substance contains 10 atoms more water, giving the formula $C_{46} H_{28} O_{28}$, 10 HO.

A compound, prepared by adding neutral acetate of lead to an alcoholic solution of the colouring matter, keeping the latter in excess, approaches the formula $C_{46}H_{28}O_{28}$, 2PbO, 8HO.

When xanthorhamine is boiled with weak sulphuric acid, it is resolved into grape sugar and a yellow powder, which the author proposed to name Rhamnetine; showing the colouring matter to be a glucoside. In the proportion of its constituents, its softish, nearly tasteless crystals, and insolubility in ether, it agrees with these bodies generally.

The composition of rhamnetine agreed closely with the formula $C_{22}H_{10}O_{10}$. It is almost entirely insoluble in water, alcohol, and ether; alkalies dissolve it, and acids reprecipitate it from an alkaline solution. The ammoniacal solution precipitates metallic salts.

On adding the formula of rhamnetine to that of grape sugar, we have xanthorhamnine *plus* 6 atoms of water.

$$\underset{\text{Rhamnetine.}}{C_{22}H_{10}O_{10}} + \underset{\text{Glucose.}}{C_{24}H_{24}O_{24}} = \underset{\text{Xanthorhamnine.}}{C_{46}H_{28}O_{28}} + 6HO.$$

Quantitative determinations of the rhamnetine and glucose give results agreeing with this equation.

If the formula given by Kane for chrysorhamnine be doubled, we have the formula of xanthorhamnine *minus* 6 atoms of water—

$$\underset{\text{Chrysorhamnine.}}{C_{46}H_{22}O_{22}} + 6HO = \underset{\text{Xanthorhamnine.}}{C_{46}H_{28}O_{28}}$$

3. Account of some Experiments on Radiant Heat. By B. Stewart, Esq. Communicated by Professor Forbes.

The object of these experiments was to compare together the radiations from the polished surfaces of different bodies, all having the temperature of 212°. In order to heat the bodies, a tin box was used, double-sided and double-bottomed, or a box within a box. Water being kept boiling in the interval, the interior chamber was found to have a temperature of nearly 212°; and on the bottom of this chamber the bodies to be experimented on were placed. When being used these were taken out of the chamber and placed before the sentient pile of a thermo-multiplier, the galvanometer needle connected with which was immediately deviated from its zero position. The extent of the first swing of this needle was taken to denote the quantity of heat that fell upon the pile, and this deviation taking place in about 12 seconds after the substance had been taken out of the boiling water apparatus, it was found that during this small portion of time the substance might be supposed to keep its original temperature of 212°, its cooling being so small as to be neglected.

In order that different substances might be compared with one another, the same amount of heated surface was always presented to the pile.

In the first group of experiments, the quantities of heat radiated from polished plates of different substances (heated to 212°) were compared with the quantity radiated from a similar surface of lamp-black at the same temperature. It was found that glass, alum, selenite, and thick mica, radiated very nearly as freely as lamp-black; while the radiation from rock-salt was only 15 per cent. of that from lamp-black.

In the second group of experiments, the quantities of heat radiated at 212° from polished plates of the same substance, but of different thicknesses, were compared with one another.

It was found that thickness made a scarcely perceptible difference on the quantity of heat radiated by glass, a somewhat greater difference on the quantity radiated by mica, and a very sensible difference on the quantity radiated by rock-salt—a thick plate of this substance giving more than a thin plate, in the proportion of nearly 5 to 3.

The third group of experiments showed that heat from a polished plate of any substance is less transmissible through a screen of the same substance than heat from lamp-black; this difference being exceedingly marked in the case of rock-salt,—the same rock-salt screen which transmits $\frac{3}{4}$ths of the rays which fall upon it from heated lamp-black, transmitting only $\frac{1}{3}$d of the rays that issue from heated rock-salt.

The fourth group of experiments showed that heat from a thick plate of any substance is more transmissible through a screen of the same substance than heat from a thin plate.

These four groups of experiments show that the radiation from diathermanous bodies, such as rock-salt, is much less copious than that from bodies of an opposite nature, such as glass; and also that the radiation from diathermanous bodies increases with the thickness of the plate.

It was shown that all these results follow from Prevost's theory of exchanges. For if we suppose a plate of rock-salt placed in a chamber of lamp-black, all at 212°, then, since the temperature of the rock-salt remains the same, it must radiate as much as it absorbs. But since it absorbs but a small proportion of the lamp-black heat, it will radiate but a small proportion, and since a thick plate of rock-salt would absorb more than a thin plate, it would also radiate more.

The radiation of such a thin plate is therefore equal to its absorption.

It was then shown that for every separate ray of which the heterogeneous radiation of 212° is composed this equality must hold; and that for every such ray the absorption of such a thin plate = its radiation.

It was shown that the reason why rock-salt is opaque to heat from rock-salt is this. There are a few rays out of the total lamp-black radiation of 212° for which rock-salt is opaque; these rays, therefore, are rapidly absorbed by a thin plate of rock-salt; but the radiation being equal to the absorption for every kind of heat, this thin plate will chiefly radiate such rays, which will consequently be stopped by a screen of rock-salt.

In conclusion, it was shown that if we have a chamber, whose walls are composed of different substances, kept at a uniform temperature, the heat radiated and reflected together from any given portion of the surface of its wall will be independent of the nature of the substance of which that surface is composed; the only difference being, that in the case of a metal, it will be chiefly reflected and little radiated heat, while in the case of lamp-black it will be altogether radiated heat. But for all substances, radiated + reflected heat = a constant quantity.

The following Gentleman was elected an Ordinary Fellow:—

The Rev. Dr Stevenson.

The following Gentleman was elected an Honorary Fellow:—

Professor A. D. Bache, Superintendent of the United States Coast Survey.

The following Donations to the Library were announced:—

A Treatise on Electricity in Theory and Practice. By Aug. De la Rive. Translated for the Author by Charles V. Walker, F.R.S. London, 1858. 8vo. Vol. III.—*From the Author.*

Journal of the Statistical Society, March 1858.—*From the Society.*

The American Journal of Science and Art. January 1858. 8vo. —*From the Editors.*

Transactions of the Royal Scottish Society of Arts. Vol. V. Part 1. Edinburgh, 1857, 8vo.—*From the Society.*

Memorie della Accademia delle Scienze dell' Instituto di Bologna. Tomo VII. Bologna, 1857, 4to.—*From the Academy.*

Proceedings of the Royal Astronomical Society. Vol. XVIII. No. 4.—*From the Society.*

Proceedings of the Royal Society of London. Vol. IX. No. 29.—*From the Society.*

Map of England and Wales, showing the Path of the Centre of the Moon's Shadow on the 15th March 1858.—*From H. F. Talbot, Esq.*

Monday, 5th April 1858,

THE RIGHT REV. BISHOP TERROT in the Chair.

The following Communications were read:—

1. On the Facets and Corners of Flat-Faced Solids. By Edward Sang, Esq F.R.S.E.

In this paper it was shown that the usually received theorems concerning the faces of polyhedrons are true only of one class of solids. The theorem that "*no solid can have every one of its faces more than pentagonal*" was contradicted by the exhibition of a solid bounded entirely by hexagons. Each corner of this solid is trihedral, and the sum of all its angles amounts to four times as many right angles as there are corners; whereas the usual theorem is, that "*the angles of any solid amount to four times as many right angles as there are corners, less* EIGHT." The number of uniformal solids, that is of solids of which all the faces have the same number of sides, and all the corners the same number of angles, instead of being *five*, was shown to be indefinite by the exhibition of the solid

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2. Biographical Notice of the late Professor Edward Forbes. By Prof. George Wilson.

Monday 19*th April*, 1858.

Dr CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. Notice respecting the remains of a Seal, in the Pleistocene of Fifeshire. By Dr Allman.

Professor Allman exhibited a portion of a pelvis of a seal, which had been recently obtained from the Pleistocene deposits in the neighbourhood of Kirkaldy, and sent to him for determination by Mr Martin Rigney of that place.

From a note received from Mr Rigney, it appears that the bone was found in the Tyrie clayfield, about two miles west of Kirkaldy, and about a quarter of a mile from the shore of the Firth, and that it lay 18 or 19 feet below the surface of the soil, and about 30 feet above the present level of high-water. It was unaccompanied by any other remains.

Mr Page had already noticed the occurrence of a very perfect skeleton of a seal from another locality in Fifeshire; and the great rarity of such remains in the British Isles appeared to Professor Allman a sufficient reason for placing the present instance also on record.

2. On Theories of the Constitution of Saturn's Rings. By Professor Clerk Maxwell.

The planet Saturn is surrounded by several concentric flattened rings, which appear to be quite free from any connection with each other, or with the planet, except that due to gravitation.

The exterior diameter of the whole system of rings is estimated at about 176,000 miles, the breadth from outer to inner edge of the entire system, 36,000 miles, and the thickness not more than 100 miles.

It is evident that a system of this kind, so broad and so thin, must depend for its stability upon the dynamical equilibrium between the motions of each part of the system, and the attractions which act on it, and that the cohesion of the parts of so large a body can have no effect whatever on its motions, though it were made of the most rigid material known on earth. It is therefore necessary, in order to satisfy the demands of physical astronomy, to explain how a material system, presenting the appearance of Saturn's Rings, can be maintained in permanent motion consistently with the laws of gravitation. The principal hypotheses which present themselves are these—

I. The rings are solid bodies, regular or irregular.
II. The rings are fluid bodies, liquid or gaseous.
III. The rings are composed of loose materials.

The results of mathematical investigation applied to the first case are,—

1*st*. That a uniform ring cannot have a permanent motion.

2*d*. That it is possible, by loading one side of the ring, to produce stability of motion, but that this loading must be very great compared with the whole mass of the rest of the ring, being as 82 to 18.

3*d*. That this loading must not only be very great, but very nicely adjusted; because, if it were less than ·81, or more than ·83 of the whole, the motion would be unstable.

The mode in which such a system would be destroyed would be by the collision between the planet and the inside of the ring.

And it is evident that as no loading so enormous in comparison with the ring actually exists, we are forced to consider the rings as fluid, or at least not solid; and we find that, in the case of a fluid ring, waves would be generated, which would break it up into portions, the number of which would depend on the mass of Saturn directly, and on that of the ring universally.

It appears, therefore, that the only constitution possible for such a ring is a series of disconnected masses, which may be fluid or solid, and need not be equal. The complicated internal motions of such a ring have been investigated, and found to consist of four series of waves, which, when combined together, will reproduce any form of original disturbance with all its consequences. The motion of one of these waves was exhibited to the Society by means of a small mechanical model made by Ramage of Aberdeen.

This theory of the rings, being indicated by the mechanical theory as the only one consistent with permanent motion, is further confirmed by recent observations on the inner obscure ring of Saturn. The limb of the planet is seen through the substance of this ring, not refracted, as it would be through a gas or fluid, but in its true position, as would be the case if the light passed through interstices between the separate particles composing the ring.

As the whole investigations are shortly to be published in a separate form, the mathematical methods employed were not laid before the Society.

3. On a peculiar Ligament connecting the opposite Ribs in certain Vertebrata. By Dr Cleland. Communicated by Professor Goodsir.

While examining the bones of a seal which had been for some time in maceration, the author observed that, in detaching one of the ribs from the vertebral column, a long ligament, connected to the head of the former, emerged from the intercostal foramen.

It was then found that the right and left rib in all the pairs articulating with two vertebræ were connected across the mesial plane by a ligament which was attached at each end to a depression on the lower part of the continuous convex cartilaginous surface of the head of the rib, and was lodged in a tube on the floor of the spinal canal, formed by a groove on the upper surface of the corresponding intervertebral disc covered by the superior longitudinal ligament, and lined by a synovial membrane common to the tube, the ligament contained in it, and the entire heads of both the ribs.

It appeared probable that this peculiar transverse intercostal ligament would be found developed in the mammalia directly as the flexibility of the spine.

In the weasel and squirrel it is fully developed; also in the lion, fox, and dog; but in the three latter the single synovial membrane common to the entire arrangement only lines the groove on the superior edge of the intervertebral disc and the under surface of the ligament, the latter being thus in contact above with the superior longitudinal ligament of the spine.

In the sheep and horse the fibres of the anterior half of the ligament are attached midway to the posterior superior margin of the body of the vertebræ in front. In the sheep there are two synovial membranes for the head of each rib,—the posterior on each side communicating across the mesial plane behind the ligament. In the horse there are not only two synovial membranes for the head of each rib, but an intermediate one for the ligament itself.

In the rabbit, fibres extend across from the head of one rib to that of the opposite, but are closely incorporated with the intervertebral disc.

In the kangaroo, monkey, and human subject, there is no trace of the transverse intercostal ligament.

The author is inclined to consider this transverse intercostal ligament as represented by the transverse ligament of the atlas, and both structures as morphologically related to the perforated form of the intervertebral disc.

The communication concluded with observations on the relative movements of the ribs and spine, in connection with this ligament; and on its probable functions.

4. On the Movements of the Articulation of the Lower Jaw. By Dr John Smith. Communicated by Professor Goodsir.

After alluding to the difficulty of determining the precise anatomical configuration of the condyles of the lower jaw, especially in the human subject, the temporo-maxillary articulation admitting of a multiplicity of movements, and these again being liable to modification by different accidental and other conditions of relative structures, such as the teeth, &c., the author stated that a general principle would nevertheless be found to prevail, and in general to be distinctly traceable in this joint, whatever might be the modifications existing either in its function or external form.

In man, and many of the mammalia, one essential movement of the lower jaw consists in simply opening and shutting the mouth, in a vertical plane: here the temporo-maxillary articulation is said to act as a *simple hinge*. Another essential motion is that by which grinding of substances between the molar teeth during mastication is performed: here the action of the joint has apparently been regarded as somewhat irregular and subordinate in its nature.

In the first-mentioned movement, however, the condyles cannot act as a *simple hinge*, as they lie—not at right angles to the plane of motion of the lower jaw—but obliquely to it, each condyle looking inwards and forwards. Their more perfect action, therefore, cannot occur in this movement, but seems to belong to the second we have mentioned, viz., that of mastication.

The articulating surface, strictly speaking, on each condyle appears to constitute the thread, or rather part of the thread, of a conical screw passing over an axis lying at or about right angles to the plane of motion in simple opening and closing of the jaws. This spiral course of the articular surface is perhaps best seen in some of the larger carnivora, such as the lion, but is also obvious in a well-developed human condyle.

The action of this conical screw or tap within the glenoid cavity, considered as the conical die, takes place with accuracy only when one joint alone acts with the condyle within the glenoid cavity—the other condyle being beyond it, and gliding upon the surface of the zygoma, as during mastication. The food is in this process crushed between the molar teeth of that side whose condyle remains within the glenoid cavity; this condyle screwing the jaw back, so to speak, to its natural position at each closure of the teeth.

By this construction a great amount of friction is avoided; what would otherwise be a *rubbing* being thus converted into a *rolling* motion between the condyloid and glenoid surfaces; while by one or other condyle always remaining in the glenoid cavity during mastication greater steadiness and security is afforded to the joint.

5. On some properties of Ice near its Melting Point. By Professor Forbes.

"During the last month of March I made some experiments on the properties of ice near its melting point, with particular reference to those of Mr Faraday, published in the Athenæum and Literary Gazette for June 1850, to which attention has been more lately called by Dr Tyndall and Mr Huxley in relation to the phenomena of glaciers.

"Owing to indisposition, I have been obliged to leave my experiments for the present incomplete. But I am desirous, before the session of the Royal Society closes, to place on record some facts which I have observed, and also some conclusions which I deduce from these and other recent experiments and discussions.

"Mr Faraday's chief fact, to which the term 'regelation' has been more lately applied, is this, that pieces of ice, in a medium above 32°, when closely applied, freeze together, and flannel adheres apparently by congelation to ice under the same circumstances.

" 1. These observations I have confirmed. But I have also found that metals become frozen to ice when they are surrounded by it, or when they are otherwise prevented from transmitting heat too abundantly. Thus a pile of shillings being laid on a piece of ice in a warm room, the lowest shilling, after becoming sunk in the ice, was found firmly attached to it.

" 2. Mere *contact*, without *pressure*, is sufficient to produce these effects. Two slabs of ice, having their corresponding surfaces ground tolerably flat, were suspended in an inhabited room upon a horizontal glass rod passing through two holes in the plates of ice, so that the plane of the plates was vertical. Contact of the even surfaces was obtained by means of two very weak pieces of watch-spring. In an hour and a half the cohesion was so complete, that, when violently broken in pieces, many portions of the plates (which had each a surface of 20 or more square inches) continued united. In fact, it appeared as complete as in another experiment where similar surfaces were pressed together by weights. I conclude that the effect of pressure in assisting "regelation" is principally or solely due to the larger surfaces of contact obtained by the moulding of the surfaces to one another.

" 3. Masses of strong ice, which had already for a long time been floating in unfrozen water-casks, or kept for days in a thawing state, being rapidly pounded, showed a temperature 0°·3 Fahrenheit below the true freezing point, shown by delicate thermometers (both of mercury and alcohol), carefully tested by long immersion in a considerable mass of pounded ice or snow in a thawing state.

" 4. Water being carefully frozen into a cylinder several inches long, with the bulb of a thermometer in its axis, and the cylinder being then gradually thawed, or allowed to lie for a considerable time in pounded ice at a thawing temperature, showed also a temperature decidedly inferior to 32°, not less, I think, than 0°·35 Fahrenheit.

" I think that the preceding results are all explicable on the one admission, that Person's view of the gradual liquefaction of ice is correct (*Comptes Rendus*, 1850, vol. xxx. p. 526),* or that ice

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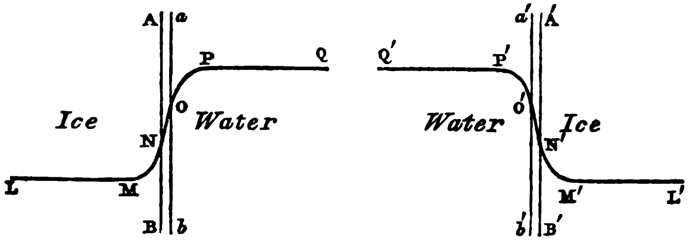
* Quoted by me in 1851, in my sixteenth letter on Glaciers.

gradually absorbs latent heat from a point very sensibly lower than the zero of the centigrade scale.

"I. This explains the permanent lower temperature of the interior of ice.



"Let AB be the surface of a block of ice contained in water at what is called a freezing temperature. That temperature is marked by the level of the line QP above some arbitrary zero. LM is, in like manner, the permanent but somewhat lower temperature possessed by the interior of the ice. The space, partly water, partly ice, or partaking of the nature of each, MNOP, has a temperature which varies from point to point, the portion NO corresponding to what may be called the physical surface of the ice between AB and *ab*, which is "plastic ice," or "viscid water," having the most rapid variation of local temperature.

"II. Such a state of temperature, though it is in one sense permanent, is so by compensation of effects. Bodies of different temperatures cannot continue so without interaction. The water *must* give off heat to the ice, but it spends it in an insignificant thaw at the surface, *which therefore wastes even though the water be what is called ice cold*, or having the temperature of a body of water inclosed in a cavity of ice.*

"This waste has yet to be proved; but I have little doubt of it; and it is confirmed by the wasting action of superficial streams on the ice of glaciers, though other circumstances may also contribute to this effect.

"III. The theory explains "regelation." For let a second plane surface of ice A′B′ be brought up to nearly physical contact with

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"* I incline to think that water, in these circumstances, may, though surrounded by ice, have a fixed temperature somewhat higher than what is called 32°. But I have not yet had an opportunity of verifying the conjecture.

"[My idea is that the invasion of cold from the surrounding ice is spent in producing a very gradual "regelation" in the water which touches the ice, leaving the interior water in possession of its full dose of latent heat, and also the first surface AB. There is a double film of "viscid water" isolated between two ice surfaces colder than itself. The former equilibrium is now destroyed. The films AB*ba* and A'B'*b'a'* were kept in a liquid or semi-liquid state by the heat communicated to them by the perfect water beyond. That is now removed, and the film in question has ice colder than itself on both sides. Part of the sensible heat it possesses is given to the neighbouring strata which have less heat than itself, and the intercepted film of water in the transition state becomes more or less perfect ice.

"Even if the second surface be not of ice, provided it be a bad conductor, the effect is practically the same. For the film of water is robbed of its heat on one hand by the colder ice, and the other badly-conducting surface cannot afford warmth enough to keep the water liquid.

"This effect is well seen by the instant freezing of a piece of ice to a worsted glove even when on a warm hand. But metals may act so, provided they are prevented from conveying heat by surrounding them with ice. Thus, as has been shown, metals adhere to melting ice."

Edinburgh, 19th April 1858.

The following Donations to the Library were announced:—

Monthly Return of the Births, Deaths, and Marriages, registered in the eight principal towns of Scotland, with the causes of Death, at four periods of Life, March 1858.—*From the Registrar-General.*

Supplement to the Monthly Returns of Births, Deaths, and Marriages. Year 1857.—*From the Registrar-General.*

Monatsbericht der Königlichen Preuss Akademie der Wissenschaften zu Berlin. Sept., Oct., Nov., Dec. 1857. 8vo.—*From the Berlin Academy.*

The American Journal of Science and Art. March 1858, 8vo.—*From the Editors.*

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of a temperature which may slightly exceed 32°. By similar reasoning, a small body of ice, inclosed in a large mass of water, will preserve its proper internal temperature *below* 32°; but, instead of regelation taking place, the surface is being gradually thawed. This is the case contemplated in the paragraph of the text to which this note refers.]"

N.B.—*The words in brackets were added to this note during printing.* 13*th May* 1858. J. D. F.

Proceedings of the Royal Medical and Chirurgical Society of London. Vol. II., No. 1. London, 1858. 8vo.—*From the Society.*

Catalogue of the Antiquities of Stone, Earth, and Vegetable Materials in the Museum of the Royal Irish Academy. By W. R. Wilde, M.R.I.A. Dublin, 1857.—*From the Irish Academy.*

Account of the Astronomical Experiment of 1856, on the Peak of Teneriffe. By Professor C. Piazzi Smyth, Astronomer Royal for Scotland.—*From the Author.*

Monthly Notices of the Royal Astronomical Society, from November 1856 to July 1857. Vol. XVII. London, 1857. 8vo.—*From the Society.*

Memoirs of the Royal Astronomical Society. Vol. XXVI. London, 1858. 4to—*From the Society.*

Mémoire sur un rapprochement nouveau entre la Théorie moderne de la propagation linéaire du son, dans un tuyau cylindrique, horizontal d'une longuer indífinie et la Théorie des pulsions, exposée par Newton dans les deux Propositions XLVII, et XLIX du second Livre des Principes, par Jean Plana. Turin, 1857. 4to.—*From the Author.*

Mémoire sur la mouvement conique à double courbure d'un pendule simple dans le vide abstraction faite de la rotation diurne de la terre, par Jean Plana. Turin, 1858. 4to,—*From the Author.*

Abhandlungen der Köeniglich Bayerischen Akademie der Wissenshaften. Mathem.-Physikalischen Classe, achten Bandes, erste abtheilung. Philosoph. philologischen Classe, achten Bandes, erste und and zweite abtheil. Munchen, 1856. 4to.—*From the Bavarian Academy.*

Proceedings of the Zoological Society. Nos. 339–348. London, 8vo. —*From the Society.*

Gelehrte Anzeigen der K. Bayerischen Akademie der Wissenschaften. Bände 42–45. Munchen, 1856–57. 4to.—*From the Bavarian Academy.*

Comptes Rendus hebdomadaires des Séances de l'Academie des Sciences, par MM. les Secretaires perpetuels. Paris, 1857–8. —*From the Academy.*

Madras Journal of Literature and Science, edited by the Committee of the Madras Literary Society, and Auxiliary Royal Asiatic Society, Vols., I., II., and III., of New Series.—*From Dr Cleghorn, Madras.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. IV. 1858–59. No. 49.

Seventy-Sixth Session.

Monday, 22d November 1858.

Dr ALISON, Vice-President, in the Chair.

The following Council were elected :—

President.

Sir T. MAKDOUGALL BRISBANE, Bart., G.C.B.

Vice-Presidents.

- Sir David Brewster, K.H.
- The Very Rev. Principal Lee.
- The Right Rev. Bishop Terrot.
- Dr Christison.
- Dr Alison.
- Professor Kelland.

General Secretary,—Professor Forbes.

Secretaries to the Ordinary Meetings,—Dr Balfour, W. Swan, Esq.

Treasurer,—J. T. Gibson-Craig, Esq.

Curator of Library and Museum,—Dr Douglas Maclagan.

Councillors.

- Dr Thomas Anderson.
- Rev. Dr Hodson.
- Robert Chambers, Esq.
- John Russell, Esq.
- John Hill Burton, Esq.
- David Stevenson, Esq.
- Wm. Thos. Thomson, Esq.
- Dr Allman.
- The Duke of Argyll.
- Andrew Murray, Esq.
- Dean Ramsay.
- Dr Geo. Wilson.

Monday, 6th December 1858.

PROFESSOR KELLAND, Vice-President, in the Chair.

1. Opening Address. By Professor Kelland.

During the vacation, I had looked forward with confidence to the pleasure of listening to-night to an address from one of the ablest experimenters and most vigorous writers that this Society has ever numbered amongst its members,—Sir David Brewster. And when, a short time since, I learnt that I had been indulging an ill-founded expectation, and that the duty of opening the session was to fall to my own lot, I experienced something more than disappointment. For, in addition to my imperfect knowledge of the past history and present position of the Society, is the fact that I had made no preparation, either in the way of collecting materials, or of providing a reserve of time, for drawing up an address. I must therefore come before you with an apology. I must crave your forbearance should some of the remarks which I make appear trite and unworthy of the occasion,—should others be traceable to what I have said elsewhere,—should all be found crude and lower in tone than beseems the position in which your kindness places me.

The primary topic in such an address must be one suggested by the first glance which the eye takes around the room on every opening session—the record of the changes which death has effected in our body. The list of members deceased within the year is, I regret to say, unusually large, comprising no fewer than two honorary, and fifteen ordinary Fellows. Amongst these are names of note, —such as those of Lord Dunfermline, the Lord Justice-Clerk Hope, and Lord Handyside,—men whose distinguished professional career has brought them prominently before the public, and the tribute to whose memory is recorded on broader pages than issue from this place. There are others, whose walks in life, and scientific pursuits in particular, brought their doings more directly under our notice, —such as Dr Fleming, Professor Gregory, Mr Jamieson Torrie, Mr Tod, Mr Jardine, and Mr Morries Stirling.

In selecting some of these for a few brief remarks, I trust it may not be inferred that I deem the others little worthy of notice. A sketch of the labours of Dr Fleming has already been laid before the Society. A brief notice of Professor Gregory has been drawn up by Dr Alison, and he has come here to-night to present it to the Society in person. Time and opportunity have been wanting to me to collect extensive information respecting Mr Tod and Mr Jardine; whilst in the cases of Mr Jamieson Torrie and Mr Morries Stirling, I have had the advantage of the kind assistance of Dr Balfour, Dr Christison, and Mr Andrew Coventry.

Suffice it to say, that Mr Tod was for no less than twenty-nine years Secretary to the Royal Scottish Society of Arts, the duties of which office he discharged with such efficient and ready zeal as to have rendered himself ultimately the centre and moving power of that Society, by every member of which he was highly and deservedly esteemed. On our own meetings he was a regular attendant; but he reserved his active energies for the Society to which his tastes and his official position more directly attached him. As a disinterested patron of youthful inventors, as a friend to every unfriended projector, his loss will be severely felt.

Of Mr Jardine all I can collect is, that he possessed keen intelligence and great mathematical powers. In his early career he is said to have given promise of the highest eminence, attracting the attention of Professor Playfair, to whom he was under deep obligations. I possess a copy of a book presented to him by the author—the Supplement to Legendre's "*Théorie des Nombres.*" The testimony, even to this extent, of so distinguished a man as Legendre, is no small matter. Mr Jardine appears to have been too easily satisfied with the position which his professional skill as a civil engineer secured him, to admit of his using the exertion requisite for figuring in a broader sphere. His attainments, however, were by no means limited to a knowledge of his profession.

Fifty years ago, when geology was not a common study, Mr Jardine laboured in that field; but the fruits of his labours were, so far as I know, communicated only to his friends. It was a merit even to study amongst the rocks in those days; when the country-people were not accustomed, as they are now, to meet with gentlemen converted for the time into stonebreakers. Professor Sedgwick tells a story of his arriving late, hammer in hand, and groaning under a load of specimens, at a little inn in some remote district, and of the worthy Boniface bringing out in turn each of his children from its bed to have a look at the "daft" man. I am reminded of this story by what I have been told of Mr Jardine. When Professor Jameson was on his first visit to Arran, collecting materials for the mineralogy of the island, he on one occasion arrived, after nightfall, at a public-house near Loch Ranza, and asked if he could obtain some refreshment and a bed. The reply was, "Aye, aye, ye may hae some refreshment, but for a bed ye maun e'en lie down beside that man on the table." To Jamieson's no small delight and astonishment, "that man" was his friend Jardine, sound asleep, after a hard day's geologizing amongst the hills.

Thomas Jameson Torrie, Esq., Advocate, evinced in early life a fondness for natural science, which, under the able tuition of his uncle, Professor Jameson, resulted in his becoming an excellent mineralogist and geologist. He was also distinguished in Botany. He became a member of the Plinian Society in 1824, and was elected President of that Society in 1827. He contributed papers to the Society, and proved himself a zealous student of natural science. In 1828 he joined the Wernerian Society, and became ultimately associated with Dr Neill in the secretaryship. Owing to his retiring habits, Mr Torrie did not appear much in public, either as a speaker or as a writer. He did much, however, to encourage science, by the ample collections which his independent fortune enabled him to accumulate. He had travelled extensively, and was well acquainted with the geology of Europe. To the loss of science, he was attacked, whilst in the vigour of life, by rheumatism, brought on by exposure. The attack was succeeded by partial paralysis, which affected both his powers of memory and his speech. Hence it happened that for many years, whilst warmly interesting himself in all that was doing in natural history, his own participation in the labours of scientific progress was effectually stopped. He was much beloved by an extensive circle of friends.

Mr John Davy Morries Stirling, was son of Captain Morries, of the Royal Navy, and nephew of Major Davy, a distinguished officer, who perished in captivity in Candy in Ceylon, after the well-known fatal expedition against that capital early in the present century. Mr Morries was educated in Edinburgh for the medical profession, and graduated in 1831, after having given great promise as a student. Both before and after graduation he showed a preference for chemical inquiry, and manifested an aptitude for original research. To him is due the discovery of one of the neutral crystalline proximate principles of the vegetable world, *elaterine*, the active ingredient of *elaterium*, which was also made known by the late Mr Hennell of London about the same time. Subsequently, the first appearance of the malignant cholera, in 1832, attracted his ardent mind,—at the time a subject of universal and intense interest,—and thus, for a period, the practice of his profession became the object of Dr Morries' life; and he settled in London as a physician. Circumstances soon led him, however, to give up that pursuit; and marriage with a lady of property, sister of the present Mr Stirling of Kippendavie, occasioned a change of name, and the abandonment of all professional objects. Not long after his marriage Mr Morries Stirling took up his residence in Norway, where he remained several years. The account of the discovery of the admixture of metals, on which was founded his patent iron, and several other patents, which have been successfully worked, I owe to the kindness of Mr Andrew Coventry. When residing in Norway, Mr Stirling devoted his time to field-sports, in which he engaged with great enthusiasm. Hunting, shooting, and fishing occupied his days whenever it was possible to get abroad. But, as the weather was not always propitious, he was sometimes kept within doors. On these occasions, he tried his hand at the construction of the implements used in the field. On one occasion, he was astonished to find the fish-hooks, which his experiments had produced, to possess wonderful toughness, quite different from anything he had previously turned out. With a true philosophic spirit, he set about diligently to search out the cause. Had he done anything unusual? Was there any element, either of matter or of manner, to which he might attribute his success? He could discover none. But his man, on being questioned, remembered that they had stirred the molten metal with a tin spoon. On this hint, he repeated the experiment, and the result was the patent iron, which consists of a mixture of iron with tin or some other metal. To this he has added other patents of great value. And here permit me to offer a word of caution to our younger Fellows. The principle of division of labour seems almost to be a law of nature—it is certainly a law of society. The genius which evolves a scientific invention is rarely, very rarely indeed, combined with that genius which can turn it to profitable account. A tightly-strung mind, capable of working out scientific truths, is hardly able to sustain the rough shocks which it meets with in the commercial world. Mr Stirling found his patents, successful as they were in some respects, a constant source of annoyance, under which his sensitive frame gave way. Others profited: he suffered. *Sic vos non vobis.*

The names of the other ordinary members deceased are,—Sir David Hunter Blair, Bart.; James M. Hog, Esq. of Newliston; William Murray, Esq. of Monkland; John Sligo, Esq. of Carmyle; Dr John W. Watson; and William Wood, Esq.*

Of foreign members, we have lost M. Von Hammer the Orientalist, and Müller the Physiologist.

Little remains to be added to complete the past year's history of the Society. The papers read at our ordinary meetings have presented the usual diversity of subject; embracing Mathematics, Physics, Chemistry, Natural History, and Archæology. Nor am I aware that their value has been below the average; but, from the circumstance that several of the most important papers were incomplete, combined with the fact that shorter papers are now more generally condensed into our Proceedings than was the case formerly, the annual addition to our Transactions this year contains but one paper. That paper is by Mr Stewart, and is of unquestionable merit. I have great pleasure in learning that Mr Stewart is continuing his researches on radiant heat,—a branch of experimental science which owes so much to members of this Society, and the papers on which alone suffice to stamp our Transactions with lasting value. I ought to add, that Mr Stewart has been selected by the Council to take charge of the reduction and printing of the "Makerstoun Magnetical and Meteorological Observations," at the joint expense of Sir Thomas Brisbane our President, and of the Society, with which work he is progressing rapidly and satisfactorily. Having thus briefly touched on the occurrences which make up the history of the Society during the past year, I will venture on a few general remarks.

I have no fear that the principles which should regulate such associations as this are likely to be much misunderstood or widely

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* Whilst I write, there reaches me intelligence of the death of two other ordinary members—Lord Haddington and Mr Alexander Adie, both at an advanced age.

departed from. Still, a few words on the subject may not be inappropriate to the occasion. There are two errors which we must carefully guard against in our practice:—the one, that of imagining this room to be a place proper for the exposition of old truths,—in other words, as in any sense a lecture-room; the other, that of regarding our Society as, to any large extent, a combination of force, a union of physical and pecuniary appliances wherewith to attack problems and institute experimental researches which could not readily be dealt with by individuals. It is quite true that most of the old learned societies were established with a view to one or the other of these objects. The Academia del Cimento, for instance, was founded for the purpose of instituting experiments on a scale which no individual philosopher of that age durst have ventured on single-handed. So, too, of the Royal Society of London. The writings of Bacon had just opened a wide vista to the eye of the investigator of nature, and from this cause, amongst others, men's minds were beginning to entertain hankerings after new forms of truth. To the eye of the philosopher, who sees in the retardation and gradual dispensation of knowledge the hand which retains the shower until the seed has lain its full time in the earth, the phenomenon is neither startling nor inexplicable, of men hurrying to and fro under the influence of some excitement, whose determining period is in the future. The old Royal Society was assuredly composed of men drawn together by strange unearthly longings, the interpretation of which must be sought for in the subsequent quarter of the century, when the "Principia" and strict experimental philosophy had come in. The pages of Birch indicate plainly enough what was the object of that Society at its first formation. They reveal to us the fact, that the streams of truth had stagnated so long amongst the marshes of the Middle Ages as to have become altogether polluted, so that an individual thirsting for its waters found himself utterly suffocated, utterly helpless, in attempting to search out the pure descending rill. Impelled by this feeling of inability, men clung to each other, held firmly hand to hand, and thus united marched on. We may smile at the apparent frivolity of many of their earlier papers, but they convey their lesson notwithstanding. Their first President, Sir Robert Moray, on the day of his first election, 6th March 1661, gives in a marvellous paper, in which he tells his hearers, that the drift-wood cast ashore on the Western Isles of Scotland is incrusted with multitudes of little shells, having within them little birds perfectly shaped, supposed to be barnacles. "The bird in every shell that I opened," he says, "as well the least as the biggest, I found so curiously and completely formed, that there appeared nothing wanting as to the external parts for making up a perfect sea-fowl; every little part appearing so distinctly, that the whole looked like a large bird seen through a concave or diminishing-glass, colour and feature being everywhere so clear and neat. The little bill like that of a goose, the eyes marked, the head, breast, neck, wings, tail, and feet formed; the feathers everywhere perfectly shaped," and so on.

We may smile, I say, at this tendency to interpret natural phenomena by the aid of a vigorous imagination, but we must admit that it was better than that stolid uninterpretativeness which preceded it; and, at any rate, it ended in the clear day of truth which the next generation saw in full blaze. The object of an association at such a period was, from the nature of the case, union of minds and hands in questioning nature. What could one man hope to do by his own intellect, by his own resources? Accordingly, we are not astonished to find that the primary objects which men proposed to attain by union in those days were natural instruction, and assistance in common inquiry. The Society's minutes of the period abound in the language of entreaty. Every man who had a chance of getting at information was earnestly called upon to avail himself of it. And we are not to condemn men, through the application of our superior enlightenment, because, like the Florentine academicians, they made it a rule to believe everything possible until the contrary could be proved. They were justified, I think, in ordering fresh hazel rods to be produced, "wherewith the divining experiment was tried and found faulty." And we cannot blame them because, when the Duke of Buckingham had presented the Society with a piece of a unicorn's horn, they proceeded to try its virtues in retaining within a charmed circle a poor spider, which, however, contrived to run away spite of their repeated efforts.

Now, our circumstances are very different from theirs. Physical science is not, as it was then, a dreamy mystery, struggling for life in the breasts of a few speculative philosophers. It has made itself eyes in the telescope, arms in the steam-engine, wings in electricity. It is a living thing. Men may now rest on science itself for support, and not on each other. It is only extreme cases of views pushed beyond the ideas of the age,—of views anticipatory of the future of science,—that seem to demand the support of societies. We may admit respecting some of the generalizations of Faraday and Owen, for example, that had they emanated from some remote, unheard of country-side, they would have made no immediate impression, and would have fairly seen the day only in the next generation as singular foreshadowings of doctrines then familiar. But these are exceptions, not the rule.

Neither is combination now, as of old, essential to the prosecution of experimental research. Societies, in their corporate capacities, are no longer searchers after truths. They leave that work to individuals. Not only are we not called on to unite in the prosecution of experiments, but it rarely even happens that we are called on to lend pecuniary aid to such objects. It is possible that this Society may have been too restrictive in its grants for the prosecution of experiments; but assuredly this is an error in the right direction. A Society like this should never, as it appears to me (but I, of course, give my individual opinion only), by its funds undertake researches which may either prove of doubtful value on the one hand, or form an honourable incentive to individual energy on the other. The only reasonable grounds on which I can imagine grants of this kind may be legitimately founded, are these three:—The reduction of experiments already made; the repetition or examination of old experiments; and the continuation of researches which have been presented to the Society and approved by them. And that the Society, through their Council, have practically recognised these principles will appear, when I mention that the grants which have been made during the last twenty-five years have been limited almost exclusively to the purchase of magnetical and meteorological apparatus, and to the reduction of the observations made at the Makerstoun Observatory, at the Calton Hill, and at Mr Adie's residence.

Having now pointed out what are not the objects of such a Society as this, I may be fairly expected to state what I consider those objects to be. They appear to me to consist mainly of these two,—mutual influence and publication.

The end of our intercourse is encouragement and guidance, often even restraint. The history of the world tells many a sad tale of the waste of solitary strength. Some of the most illustrious names even have suffered from the want of cotemporary corresponding genius. Witness Roger Bacon, Tycho Brahe, Landen. But this is not all. The injury which great men sustain from want of collision is not half so blighting as that which they occasionally communicate. It is the prerogative of a commanding intellect to create for itself a sort of worship, and this worship is the certain cause of the retardation of that branch of knowledge on which it has erected itself. Take Newton. When his philosophy was once mastered by his countrymen, they felt themselves elevated with him to the highest pinnacle of excellence. Here was a system of reasoning which opened all the avenues of human knowledge. They naturally considered that, in order to advance, they had only to pursue the track which he had beaten down. Progress was in their eyes simply extension of what Newton had done, and *as* he had done it. On the Continent there was no such reverence for Newton's name. Of his labours, it is true, men gladly availed themselves; but whilst bowing to his conclusions, they yielded no obedience to his methods. In respect to the Differential Calculus, Leibnitz and his followers had adopted, from the first, an alphabetical notation capable of combining with the other characters which enter into analytical reasoning,—a mode of representation as superior to that of Newton as the plain English of my pen is to the Egyptian hieroglyphics. And what followed? Whilst the continental mathematicians pushed triumphantly through the thickets of science, opening up everywhere districts rich in fertility, the English timidly followed them at a vast distance, contented now to clear away a stump, now to explore a secluded nook which the continental mathematicians in their hasty sweep over the country had passed by unnoticed. Is this to be accounted for by a difference in the genius of the people? I think not. For, since the abandonment of their old methods, since the introduction of improved processes by Peacock, Herschel, and Babbage, our island has produced mathematicians of the very highest stamp, inferior to none of their generation. The simple explanation seems to be, that our countrymen were bound hand and foot in the chains of the beautiful but inexpansible systems of Newton, and rapid progress was to them an impossibility. Nor is Newton the only great man whose influence has been excessive, and to that extent injurious. The very same thing had occurred in France in the preceding generation; and Newton and the "Principia," actually broke down the evil influence in France which they contributed to erect in England. The seventy years which lie half in the seventeenth, and half in the eighteenth century, constitute the most barren period of French science. A brilliant constellation,—Pascal, Fermat, Mersenne, with Descartes at their head,—had just set, and thick and long-continued darkness followed. The brightness of Descartes had blinded the eyes of science. Need I refer to an earlier period, when a similar influence effectually checked all progress, until Galileo broke the chain which had held the civilized world in bondage for centuries,—a chain which Aristotle, a mighty genius like Newton and Descartes, had bound about his followers. In a minor degree, the same influence has been exerted by Bacon, by Locke, and by others. Now, surely it may be expected that a Society like this, not restricted to men of one science, nor even to men of science at all, but embracing every department of human knowledge, should operate powerfully as a preventive to the recurrence of such evils. The influence of great men is rarely injurious, except at a distance, or after their personal influence has disappeared. It was so in the case of Newton. Contact destroys erroneous impressions,—changes evil into good. Correspondence and cotemporary publication produce much of the same effects. Hence great names always appear in clusters. Hooke and Huyghens, and Leibnitz and the Bernoullis, lived around Newton. It was after his death that his countrymen placed him on a solitary pedestal. Minds, like trees, spring upwards from their mutual shelter. The poet's "lodge in some vast wilderness;" the dreamland of literary leisure is not the soil in which great thoughts thrive. Real science, real philosophy, I had almost said real poetry, comes from the dwellers among their fellow-men,—comes from the smoke of great cities. The heart of man drinks in inspiration from the thoughts which are floating about it. Thus, for example, in the science of optics,—a science which seemed to be exhausted,—Malus and Biot, and Young and Brewster, and Fresnel and Arago, mutually influenced each other, and their influence extended to Fraunhofer and Cauchy, and Wollaston and Seebeck, and Airy and Herschel and Plateau, and Wheatstone and Purkinje, and Hamilton and M'Cullagh, and Lloyd and Stokes; until the list of men raised to enduring fame by a single worn-out science is too long for enumeration.

Unquestionably a large amount of the influence which is here traceable is due to publication rather than to personal contact. And this fact brings before us one of the most valuable elements of our union. The writings of deep and original thinkers in any science are not likely to be self-supporting. If successful, their success must be slow. It is only a reputation of the highest order that can ensure the sale of heavy thought. Youthful discoverers have no chance of success. In some departments of knowledge, so crushing is this expense of publication, as even to destroy societies. The Memoirs of the Analytical Society, containing papers by the greatest mathematicians of Britain, reached but one volume, of which, probably, not half a dozen copies were ever sold. "The Mathematician," and the "Cambridge and Dublin Journal," have ceased to exist. The advantage of a large society like this is, that it constitutes both the publisher and the public. Thus papers uninteresting to the mass, perhaps even uninteresting to all at the time of their publication, are handed down to future thinkers, where, in a newly turned up soil, they may grow and produce rich fruit. The work of publication is perhaps our greatest work,—perhaps our properest work. The torch of truth is hereby trimmed and passed on from age to age. The great English philosopher describes man as the interpreter of nature. But this is not his characteristic designation ; for are not the beasts, are not the birds, are not the very insects, interpreters of nature? It is as the interpreter of man—the interpreter of man's records—that man stands distinguished. Thus reason transcends instinct that its gifts are transmissive and cumulative. Mind does not stand supported by the mind which exists around it,—not simply, not mainly,—there is a higher and a broader support. The minds of the great of by-gone ages live and work in the breasts of their successors. The old Greeks, I suppose, knew this, and embodied it in the fable of Athene, the goddess of knowledge, who sprang into existence, not as a naked, helpless child, but as a grown-up being, clad in complete armour, from the head of Zeus.

Hence the importance of publication. It is at once the food of existing thought and the seed of future knowledge. A society such as ours has some little difficulty, it may be, in rendering its two functions of personal influence and of publication harmonious. Personal intercourse may operate injuriously on publication. It may reasonably be expected to swell our Transactions with unimportant papers, the contributions of members whose merits are viewed by too friendly an eye. On the other hand, publication may tend to sour personal intercourse. If such papers only are selected as are likely to prove valuable to cotemporary and future thinkers, there is a possibility that disappointment may ensue, and with it ill fellowship. The Council have a difficult duty in this respect, and they act wisely in referring the papers presented to them, in every case where there is the slightest doubt, to parties at a distance, out of the sphere of local influence. The estimation in which our Transactions are held is an evidence at once of the care which is bestowed in the selection of papers, and of the high scientific position of the Society. To you, the existing members, is confided the duty of maintaining that position, and of upholding the character of our Transactions before the world.

2. Account of the Life and Labours of Dr William Gregory. By Dr Alison.

Dr Gregory, at the time of his death, which took place on the 24th of April last, was Professor of Chemistry in the University of Edinburgh, and one of the Secretaries of this Society. He was born on the 25th of December 1803. His father was the late Dr Gregory; for a long time professor of the practice of medicine in the University of Edinburgh. His brothers, James Crawford, who took the degree of medicine in 1824, and died in 1832, and Duncan, who, when he died, was a Fellow of Trinity College, Cambridge, were both so highly distinguished for their talents and acquirements as to be worthy representatives of a family of no small distinction in the science and literature of the country; but, in Dr Alison's opinion, Dr William Gregory was the member of the family who, in our day, had shown the greatest original talent and devotion to science for its own sake. His love of science manifested itself at an early period. He had been present at an introductory lecture by Dr Hope, which was illustrated by striking experiments. Several of these experiments he contrived to repeat by means of a rude apparatus which he constructed for the purpose. From that time he had always before him the object of ambition which he ultimately attained. It was not, however, until he had made his name known throughout Europe as a chemist, as a favourite pupil and friend of Baron Liebig, and the approved translator of several of his works, and had established his reputation as a teacher of his favourite science in Edinburgh, Glasgow, Dublin, and King's College, Aberdeen, where he was appointed Professor of Chemistry in 1839, that he at length, in 1844, obtained the Chair of Chemistry in the University of Edinburgh.

Dr Alison next referred to Dr Gregory's published writings and scientific papers in proof of his command of practical chemistry, of his remarkable power of condensation and clear exposition of chemical principles, and of his just perception of the many important discoveries by which the science of chemistry was advanced during his lifetime. He had formed plans which, had his health permitted, would have resulted in a course of chemical instruction not surpassed in extent and importance in any single school in Europe.

It was, however, unfortunate for Dr Gregory, that though a man of large make, and capable during youth of much exertion both bodily and mental, he had neither opportunity nor disposition to take so much muscular exercise as would probably have suited his physical constitution. In consequence, also, of an attack of fever in 1826, he became liable, during the remainder of his life, to severe pain and swelling in one of his legs on any unusual exertion. It is, besides, worth notice, that he had repeatedly decided febrile attacks, which were distinctly traceable to the inhalation of sulphuretted hydrogen, and other gases, in his laboratory.

He was thus latterly compelled to restrict himself almost exclusively to occupations of a completely sedentary character, such as the acquisition of languages, for which his remarkably tenacious memory will fitted him, and the practice of music, in which he possessed a refined taste. Of late years his favourite employment was the use of the microscope: but this was not a mere amusement; for his systematic and laborious investigations resulted in various memoirs on the "Diatomaceæ," which he contributed to the "Transactions of the Royal Society of Edinburgh," and the "Microscopical Society of London."

The zeal which Dr Gregory displayed in the progress of his favourite science, chemistry, was never shown in a more interesting manner than in the composition of the "Notes on the Action of the Soil in Vegetation," which he drew up only a few days before his death, when he was with difficulty supported in bed, so as to enable him to write.

1. On the peculiar Appendage of Appendicularia, named "Haus" by Mertens. By Professor Allman.

In this communication the author called attention to the fact of his having discovered, in April last, in the Clyde, near Rothesay, numerous specimens of an Appendicularia, invested with the remarkable appendage, named "Haus" by Mertens, who originally described it in specimens captured in the North Pacific, near Behring's Straits, but which no one since his time had seen, though Appendicularia had become a subject of careful and elaborate investigation in the hands of several of the leading zoologists of the present day.*

The appendage under consideration agreed in its more essential details with that originally described by Mertens, except that no trace could be detected of the remarkable vascular network which Mertens describes as constituting so striking a feature in the specimens examined by him. There were also some differences in details of less importance,—such as in the size of the "Haus," which was here much smaller than in the Behring's Straits specimens, and in the number and shape of the bodies named "horns" by Mertens,—differences, however, which Professor Allman thinks may be referred to a difference of species in the specimens. The author also stated, that he had never witnessed the rapid renewal of the "Haus" after complete destruction, a phenomenon described by Mertens as constant.

Notwithstanding, however, these differences, Professor Allman had not the least doubt that the structure now described is the same, except specifically, with that originally described by Mertens.

2. Additional Observations on the Morphology of the Reproductive Organs in the Hydroid Polypes. By Professor Allman.

This communication was intended by the author to be in continuation of a former paper on the same subject, read before the

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* Dr S. Wright has since informed the author, that during the past autumn he observed Appendicularia in the Firth of Forth, invested with its "Haus."

Society during the previous session, and contained the following additional notices:—

Sertularia polyzonias, Linn.

The gonophore of *Sertularia polyzonias* consists of an oval capsule slightly corrugated transversely, with a short tubular, obscurely 4-toothed aperture, and having its axis occupied by a blastostyle, bearing in all the specimens examined a single sporosac.

The sporosac is produced at first as a lateral bud from the blastostyle, but soon acquires an apparently terminal position, being borne on the summit of an axile peduncle formed by the portion of the blastostyle which intervenes between it and the base of the gonophore, while the distal portion of the blastostyle seems to become more or less atrophied. The sporosac is furnished with a large simple manubrium, between whose ectoderm and endoderm the ova or spermatozoa are developed, the ectoderm retreating from the endoderm more and more as the intervening generative elements increase in volume, while the endodermal portion of the manubrium, with its cavity, continues to occupy the axis of the sporosac, extending into the middle of the mass of ova or spermatozoa. For this endodermal portion of the manubrium, round which the generative elements are developed in the sporosacs of the hydroid polypes, I have already proposed the term *spadix*;[*] while to the ectodermal layer, which now constitutes a sac immediately confining these elements, we may give the term *endotheque*, as distinguishing it from the ectotheque, or external investment of the sporosac.

The ova and spermatozoa are of the usual form, and in the male sporosac the spermatogenous tissue may be observed in various stages of development. Towards the centre of the sporosac, where this tissue immediately surrounds the spadix, we find it in the condition of a thick mass of mother-cells filled with "vesicles of evolution;" but as we recede from the centre towards the walls of the sporosac, the spermatogenous tissue may be seen to have advanced in maturity, the mother-cells having burst and liberated their contents, while in immediate contact with the endotheque is a zone of active spermatozoa, which, when liberated, are seen to be of the usual form of minute caudate corpuscles.

The generative elements are not absolutely confined to the spo-

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[*] British Association Reports for 1858.

rosacs; they also exist between the ectoderm and endoderm of a slightly dilated portion of the peduncular blastostyle, immediately below the sporosac. I have, however, never seen them here, except in a very immature condition; and it is probable that from this situation they subsequently pass into the cavity of the sporosac.

As the gonophore advances towards maturity, the sporosac is elevated towards the summit of the capsule, both by its own increase of size and by the elongation of its peduncle; and we now find in the female gonophores that the contents of the sporosac become discharged through the aperture of the gonophore into an external oval sac, which at the same time makes its appearance on the summit of the capsule; the now empty and contracted sporosac, with its spadix, remaining behind in the interior of the capsule, on the extremity of its elongated peduncle.

This extra-capsular sac communicates through the aperture of the gonophore, by means of a short tubular neck, with the cavity of the sporosac. Its walls are composed of two layers; the external one shows no trace of structure, and looks like a gelatinous investment of the sac, but it is probably a delicate membrane, separated from the internal by a rather wide interval, which is filled with a liquid; while the internal one, or that which immediately surrounds the mass of ova, may be plainly seen to be composed of nucleated cells connected with one another by a structureless intercellular substance. The internal layer would seem to be a simple extension of the endotheque of the sporosac, which now becomes protruded, in the form of a hernia, through the aperture of the gonophore. The connections of the external layer are more obscure; but it will probably be found that this membrane is an extension of the endotheque of the sporosac.

The ova which now occupy the cavity of the extra-capsular sac are each found to be enveloped in a special sac, consisting of a very delicate structureless membrane, which closely embraces the ovum, and is then continued by a narrow elongated neck towards the aperture of the gonophore, through which it is probably further continued into the sporosac, but I was unable to trace it beyond this point.

The ova in the extra-capsular sac are in a more advanced stage of development than in the sporosac; segmentation has begun, and all traces of germinal vesicle and spot have disappeared. After segmentation has been established, the ovum may be easily broken down into distinct cells, with granular contents, but with no evident nucleus. It soon acquires a more elongated form, exhibits a manifest contractility of its walls, becomes clothed with vibratile cilia, and, finally, by the rupture of the confining structures, escapes as a free locomotive embryo into the surrounding water.

I have not as yet met with any instance of the occurrence of the extra-capsular sac in a male gonophore; and it would thus seem to constitute a kind of marsupial appendage, into which the ova are introduced from the interior of the gonophore, in order to undergo a further development previously to their final liberation as free larvæ. It occurs, with slight modifications, in several other species, and ought to have a place in the descriptive terminology of the group. I therefore, in allusion to its position on the summit of the gonophore, propose for it the name of *Acrocyst.*

We must be careful not to confound the acrocyst with an extracapsular, medusa-like sporosac, which in certain species shows itself in a similar situation, but with which it is in no respect homologous, —the acrocyst being in an entirely different morphological category from that of the sporosacs.

Sertularia pumila, Linn.

The gonophores in this species are compressed, urn-shaped bodies, generally containing a single sporosac.

From the enlarged opercular summit of the blastostyle there extends into the interior of the gonophore a variable number of cœcal tubes. Some of these are in the form of short, simple, cylindrical processes, while others extend to a greater distance, become more or less branched, and may be traced in contact with the inner surface of the walls of the capsule to within a short distance of the attached end of the gonophore. Brown corpuscles, similar to those in the interior of the blastostyle and cœnosarc, may occasionally be seen in active motion within these cœca.

The sporosac originates as a lateral bud from the blastostyle, and contains a large, simple spadix, surrounded by the ova or spermatozoa.

The generative elements, however, are not confined to the sporosac. In the blastostyle itself numerous ova may be detected; but these are always smaller, and evidently less mature, than those in the sporosac. They are produced in the walls of the blastostyle, apparently between the endoderm and ectoderm, and are very minute towards the summit of the blastostyle, but gradually increase in size towards the point of attachment of the sporosac, and are probably thence conveyed into the cavity of the latter, where a further development awaits them.

In the condition now described, the gonophore continues during the early part of the season; but at a later period there makes its appearance in the female gonophores a spherical acrocyst, in which the ova undergo further development previously to escaping as ciliated embryos.

The young gonophore has the form of a compressed cone attached by its narrow end to the branch, and with its free end wide and slightly concave. In this state it is merely an offset from the cœnosarc of the branch, hollowed out into a cavity, which is only an extension of the common cœnosarcal cavity, and having a delicate chitinous polypary moulded over its surface.

Plumularia falcata, Linn.

The gonophores in this species are of an oval form, with a tubular apical orifice, which is closed by an opercular fleshy plug.

They commence as a minute bud, which soon presents the form of a little inverted cone, having its axis traversed by a blastostyle, which dilates at the wide or distal extremity of the cone into a hollow opercular enlargement. From the blastostyle a single sporosac is produced as a lateral bud, which ultimately, by the arrest of that portion of the blastostyle between it and the operculum, acquires a terminal position, being now supported on the summit of a very short peduncle which springs from the base of the gonophore, and which is nothing more than the proximal extremity of the original blastostyle. From this point the sporosac extends towards the summit of the gonophore, which has acquired an oval form, and which at last it completely fills. From the cavity of the opercular body which closes the summit of the gonophore several more or less branched cœcal tubes are given off into the interior of the gonophore, where they may be seen running for some distance along the inner surface of its walls towards its attached extremity.

The generative elements are produced, as usual, between the ectoderm and endoderm of the manubrium of the sporosac; and by their increase of volume, and consequent pressure, occasion, at least in the female sporosacs, the gradual absorption of the spadix, which is ultimately represented by a small irregular tubercle in the bottom of the sac.

The germinal vesicle and spot are very distinct in the young ova, and the spermatozoa present the usual form of caudate corpuscles. The larva is a ciliated, leucophrydiform body.

Laomedea flexuosa, Hincks.

The usual conformation of the gonophores, and their contents, have been described in the former paper; but there still remains to be considered a remarkable modification of the reproductive system in this species.

We not unfrequently find, especially in specimens gathered late in the season, that on the summit of the capsule, and altogether external to its cavity, there are borne certain peculiar sporosacs, with a structure presenting some interesting points of difference from that of the ordinary or intra-capsular sporosacs.

It was to these extra-capsular sporosacs as occurring in *L. flexuosa*,* that Loven long ago called attention, when he supported and developed the doctrine just then announced by Ehrenberg, of the sexuality of polypes, a doctrine which, though in its mode of statement not absolutely correct, was nevertheless full of significance.

The extra-capsular sporosacs, with their investing ectotheque, are attached by a short peduncle to the summit of the blastostyle, where the latter expands into a sort of operculum for the capsule. Two or three of them, in different stages of development, may generally be seen on a single capsule. They are nearly spherical bodies, and contain either a variable number of ova, or else a mass of spermatozoa, the generative elements in either case surrounding a central spadix. The ectotheque contains thread-cells, and there is developed from this membrane, upon the summit of the sporosac, a little crown of short cylindrical processes like rudimental tentacula. The whole body bears thus a resemblance, by no means remote, to a medusa with the opening of its umbrella contracted; but I could never find in it

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* The species on which Loven's observations were made is named by him *Campanularia geniculata*. His figures, however, are undoubtedly those of *Laomedea flexuosa*, whose distinctness from *Campanularia* (or Laomedea) *geniculata* of Linnæus has been fully proved by Dr Johnston, and from *L. gelatinosa* of Pallas, with which Johnston confounded it, by Mr Hincks.

the four radiating canals described by Loven, nor any other representative of the gastrovascular system of a medusa. When the contents have attained a sufficient degree of maturity they escape, as has been already shown by Loven, through an aperture which makes its appearance in the centre of the tentacular crown.

If we follow the development of these extra-capsular sporosacs, we shall find, as Loven has already pointed out, that they are originally produced within the capsule. They are here indistinguishable from the ordinary intra-capsular sporosacs, and originate, exactly like the latter, as buds from the blastostyle. The blastostyle, however, instead of remaining stationary, as in the ordinary gonophores, grows upwards through the aperture of the capsule, carrying out with it the most mature sporosacs, or those which are formed nearest its summit, and which thus become extra-capsular, developing from their ectotheque, while in this situation, their little tentacular crown, and, after the discharge of their contents, withering away, to be replaced by others.

Notwithstanding the resemblance which the extra-capsular sporosacs, with their investing ectotheque, bear to a medusa, they will far more easily admit of a comparison with the ordinary intra-capsular sporosacs. Of the two membranes composing their walls, the internal is undoubtedly the endotheque, while the external is just as obviously an ectotheque, differing, however, from that of an ordinary sporosac, in its being provided, for the liberation of its contents, with a definite orifice surrounded by rudimental tentacles.

We have not here, more than in the intra-capsular sporosacs, any representative of an umbrella; and I confess myself quite unable to understand the radiating canals figured and described by Loven. If this excellent zoologist has not been deceived as to the existence of such canals, they will probably be identical with the cœcal processes from the spadix which I have already described as occurring in the sporosacs of several species of hydroid zoophytes.

Sertularia tamarisca, Linn.

Sertularia tamarisca, like most of the hydroid zoophytes, is strictly diœcious, but it further presents the remarkable character of having its male and female gonophores totally different from one another in form, an important fact as regards the zoographical characterization of the species.

The male gonophores appear to be those figured by Ellis in his description of this species. They are very much compressed, somewhat obcordate bodies, with a short tubular aperture.

The female gonophores are far less simple in form. They are oval for about the proximal half of their length, and then become trihedral, with the sides diverging as they pass upwards, while the whole is terminated by a three-sided pyramid. The sides of the pyramid are cut into two or three short teeth along their edges, and each of their basal angles is prolonged into a short spine.

The trihedral portion, with its pyramidal summit, is formed of three leaflets, which merely touch one another by their edges, without adhering, so that they may be easily separated by the needle. They consist of the same chitinous material as that which invests the rest of the gonophore, formed originally, doubtless, upon the surface of an ectodermal lamina.

The male gonophore is traversed by a blastostyle, which gives origin to one or more lateral sporosacs containing the spermatogenous tissue surrounding a large spadix from which no gastro-vascular cœca are developed. The spermatozoa are unusually large, and their body, instead of presenting the more common spherical or pyramidal form, is in the shape of an elongated cylinder, with the caudal filament projecting from one end.

On laying open the female gonophore, we find that the oval or proximal portion of it is occupied by a blastostyle, which gives origin to one or more sporosacs with well developed spadix, and entirely resembling the male sporosac, except in the nature of their contents, which are here ova instead of spermatozoa.

The oval portion of the gonophore terminates upwards by closing round the distal extremity of the blastostyle, which it here encircles with a ring furnished with tooth-like processes. This oval portion constitutes the *proper capsule* of the gonophore, and is the only portion developed in the male. From the summit of the blastostyle, and apparently communicating with its cavity, several irregularly-branched cœcal tubes are given off. They lie altogether external to the proper capsule, and embrace a delicate sac, within which are one or more ova in a more advanced stage of development than that presented by the ova which are still within the capsule. These extra-capsular ova are each enveloped in a special sac, very delicate and structureless, which is continued by a narrow neck towards the summit of the blastostyle, but I failed in my attempts to trace its connections beyond this point.

The extra-capsular ova, with their investing sacs, and the surrounding cœcal tubes, would thus lie entirely exposed, were it not that they are protected by the three leaflets already mentioned as constituting the trihedral portion of the gonophore. These leaflets are given off from the external surface of the oval portion, or proper capsule, near its summit, and, being in contact by their edges, completely enclose a space which is occupied by the structures just described.

Though I have not succeeded in discovering the exact connection between the common extra-capsular ovigerous sac and the structures in the interior of the capsule, nor the precise mode by which the ova gain access to it, I have no hesitation in viewing it as a true acrocyst in which the ova undergo a further development, previously to their liberation as free embryos.

In the following three species, the gonophores contained in all the specimens I examined, *medusæ*, and never sporosacs. These medusæ have been more or less investigated by Van Beneden, Gegenbaur, Dalyell, Gosse, Hincks, Wright, and other observers, and I here give the results of my own independent examinations, as partly confirmatory of the observations of these naturalists, and as partly supplementary to them.

Eudendrium ramosum, Van Beneden.

I obtained this species in fine condition, attached to an old buoy in the harbour of Derryquin, on the Kenmare River, County Kerry, in September 1858.

The gonophores are *simple*, and are borne upon the ultimate ramuli, where they may be seen springing from the upper and lateral surfaces of the ramulus along its whole length. They are obovate, or fig-shaped bodies, each supported on a distinct peduncle, and invested by a delicate chitinous extension of the polypary.

When the gonophore reaches maturity, the ectotheque and its chitinous investment become ruptured at the summit, to allow of the escape of the medusa as an independent free-swimming zoöid.

The medusa, on escaping, is provided with a deep umbrella, which measures about $\frac{1}{20}$ of an inch across its base, where it is furnished with a well-developed velum.

The manubrium is of moderate size. It is a sub-cylindrical body; somewhat dilated at its base, and having its oral extremity surrounded by four short tentacles. These manubrial tentacles have the cells of their endoderm so disposed as to give rise to the appearance of a transverse segmentation of their cavity, and the extremity of each is surrounded by a little capitate group of thread-cells. The cavity of the manubrium is lined with cells containing red granules.

From the base of the manubrium four gastrovascular canals radiate towards the margin of the umbrella, to open there into a distinct circular canal.

At each of the four points where the radiating canals open into the circular canal, is a large bulbous dilatation of the gastrovascular system. Its cavity contains red pigment granules, and while at its proximal side it is in communication with the radiating and circular canals, it sends off from its distal side two filiform contractile tentacula; the margin of the umbrella being thus furnished with eight tentacles, arranged in four equidistant groups of two each. At the root of every tentacle is a black "eye-speck." The velum is moderately developed.

From an ordinary-sized specimen of this eudendrium, kept alive in an 8 oz. phial of sea-water, the medusæ were thrown off in such multitudes as to give a milky cloudiness to the water. They continued active with me for more than a week; but during that time no further change of form occurred, and no generative elements were developed in them.*

If we endeavour to trace the development of the gonophore from its earliest appearance to the complete formation of the medusa, we shall find that it originates as a minute solid bud from the side of the branch. In this bud a cavity may be seen communicating

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* Gegenbaur has already referred the medusal genus, *Bougainvillea*, to eudendrium as its "nurse" form, and it is evident that the little medusa here described needs only that the number of tentacles and ocelli composing each marginal group shall become multiplied, and the oral tentacles become bifurcated, in order that it may be converted into a true Bougainvillea. This change I have not witnessed, for my continued observation of the medusæ was here interrupted; but Dr Strethill Wright, who obtained the same species of eudendrium in the Firth of Forth, informs me that he has traced its medusæ into the adult Bougainvillea, with the generative elements developed in the base of the manubrium, as is well known to be their situation in this genus.

with the cavity of the cœnosarc, from which it thus forms a simple *diverticulum.* We next find that the bud has become differentiated into a peripheral and a central portion, the latter containing the diverticulum from the cavity of the cœnosarc. A further differentiation is soon seen in the central portion, which is now manifestly composed of two layers,—an ectoderm and an endoderm,—while the peripheral portion becomes enveloped externally by a delicate chitinous investment. This peripheral portion is to become the ectotheque of the simple gonophore.

From the summit of the central portion, which will afterwards become elongated into the manubrium of the medusa, four thick cylindrical cœca may be now seen to be given off; their cavities are simple continuations of the diverticulum, and they extend, with their sides in close contact with one another, towards the distal extremity of the gonophore. They are at first mere tubercles, but they gradually increase in length, becoming developed quite in the same way as the tentacles on the ordinary alimentary polype. After they have attained a certain length, the gonophore continuing at the same time to grow larger, they became separated from one another laterally, and the intervening spaces are now seen to be occupied by a web-like membrane, which extends from the base of the cœca to within a short distance of their extremities, and here terminates by a defined margin.

This membrane is composed of transversely elongated cells, and is plainly a lateral extension of the ectoderm of the cœca. Close to its free margin a narrow tube may be seen extending transversely between the four cœca, connecting them together, and becoming more and more elongated as the cœca continue to separate from one another.

In the four cœca it is now easy to recognise the radiating canals of the gastrovascular system of the developing medusa, and in the transverse tube, the circular canal of this system, while the connecting membrane is plainly the rudimental umbrella.

The distal extremities of the cœcal tubes project slightly beyond the margin of the umbrella, and here become dilated into bulbous terminations, which converge towards the axis of the gonophore, where they lie in contact with one another, and soon become very conspicuous by the accumulation in them of red pigment. From each bulb two short tentacles may now be seen to sprout, and as these continue to grow longer, they may be seen hanging into the concavity of the umbrella, where they then lie somewhat confusedly within the confined space there alloted to them.

In the meantime, a velum has become developed from the margin of the umbrella, while the central portion of the gonophore containing the diverticulum from the cœnosarc has become elongated between the four radiating canals, and may be seen projecting in the axis of the umbrella, as a wide cœcal process, with distinct ectoderm and endoderm. It is easy to recognise in this process the manubrium of the medusa; an oral aperture soon becomes formed at its extremity, and the little medusa, now expanding the margin of its umbrella, and everting its tentacula, escapes from the confinement of the ectotheque, and enters upon the free phase of its existence.

Laomedea dichotoma, Linn.

Fine specimens of this zoophyte were obtained on the south-coast of Ireland, in the beginning of September, loaded with gonophores, containing medusæ in various stages of maturity. The gonophores are compound, and consist of a blastostyle carrying numerous medusæ, which increase in maturity as they approach the summit of the blastostyle, the whole being invested in an external capsule.

The medusa, on its escape from the capsule, has a thin umbrella, which is capable of passing through almost every degree of convexity, from that of a nearly flat disc to that of a dome, embracing about ⅓d of a sphere, while it is often completely everted, so as to present the appearance of a wide hand-bell without the clapper, the manubrium then representing the handle of the bell. This last condition is that which it always assumes when swimming, the manubrium being then invariably turned *from* the direction of motion.

The base of the manubrium presents a hemispherical dilatation, and on its free extremity is borne a mouth with four well-developed lobes. Four radiating canals extend from the base of the manubrium to the margin of the umbrella, where they enter a distinct circular canal. The margin of the umbrella carries sixteen filiform tentacula,* one of these tentacula being always situated at each junction of a radiating canal with the circular canal. The tentacles are thickly set with thread-cells, and their cavity presents the septate

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* Eighteen may frequently be counted, but this is probably abnormal.

appearance found generally in the group. Close to the base the ectoderm becomes thicker, and the cavity of the tentacle here loses the appearance of being transversely divided by septa.

At the inner side of the base of every second tentacle is situated a sessile "lithocyst"; and at the inner side of the base of *every* tentacle may be seen a transparent oval space, having the appearance of a vesicle. The lithocyst consists of a spherical capsule, with a spherical, highly refractile otolite. No pigment spots occur.

A narrow velum extends round the margin of the umbrella.

Exactly in the middle, between each pair of radiating canals, may often be witnessed an appearance like a bundle of delicate fibres, extending from the base of the manubrium to the marginal canal, where it loses itself, by appearing to break up into its component fibres. I believe this appearance is due to mere folds in the inner surface of the umbrella.*

Towards the end of October I again visited the locality where I had previously obtained the Laomedea in great abundance and perfection, but found nothing but dead specimens, from which the gonophores had all fallen.

Campanularia Johnstoni, Alder.

This species was dredged in September, loaded with gonophores, whose contents were in every instance medusæ.

The gonophores may be described as cask-shaped, or of the form of a regular oval, truncated at both extremities. They are corrugated transversely, so as to present a series of regular rings. They are situated on the creeping stolon of the zoophyte, to which they are attached by a short peduncle. They consist of a blastostyle, with medusal buds and investing capsule, and never carried sporosacs.

The medusa, on escaping from the gonophore, has a diameter of about $\frac{3}{100}$ of an inch. The umbrella is very convex, embracing about two-thirds of a sphere. From the base of the manubrium four radiating canals extend to the margin of the umbrella, to unite with the circular canal, and at each point of union arises a tentacle. The tentacle commences with a wide base, which passes rather

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* The medusa of *Laomedea dichotoma*, as here described, is probably only the young state of Gegenbaur's *Eucope polystyla* (Zeit. f. Wiss. Zool. Band. 8), a species which this naturalist informs us he has traced to the gonophores of one of the campanularidæ.

abruptly into a very extensile filament, which in its completely contracted state I have always found coiled into a regular spiral. The base of the tentacle presents a large cavity, which communicates freely with the marginal canal of the umbrella.

Between each of the four tentacles are two lithocysts. They consist each of a spherical transparent colourless vesicle, containing a spherical highly refractile otolite, which is itself immediately invested by a very delicate vesicle, of which it looks like the nucleus. Between each lithocyst the margin of the umbrella is extended into a slight projection, having all the characters of a rudimental tentacle.

There is a very wide velum, and in both it and the umbrella muscular bundles are largely developed.

In no instance were generative sacs developed in the specimens which came under my examination. Gegenbaur, however, has found them well developed on the course of the radiating canals in certain species of his genus *Eucope*, a genus to which he would refer all such forms as those here described in *Laomedea dichotoma*, and *Campanularia Johnstoni*, and which, he tells us, he has traced to gemmation from the Campanularidæ. In the undoubted medusæ of *Campanularia Johnstoni*, they have been seen in a similar situation, but not fully determined, by Mr Gosse, while the detection in them of distinctly formed ova by Mr Hincks, and more especially by Dr S. Wright, who has figured and described them, has so far completed the observations needed on this point.

General Conclusions.

To the general conclusions contained in the previous paper, the following generalizations may now be added.

Besides the ordinary development of the ova in intra-capsular sporosacs, we find,

1. That in certain species bearing capsular gonophores (*Sertularia polyzonias*, &c.) the ova, after attaining in the interior of the capsule a definite stage of development, are transmitted into an extra-capsular sac (*acrocyst*), where they undergo a further development previously to their liberation as free embryos, and that this sac is formed (at least in the species where its connections were most satisfactorily traced) by a hernial protrusion of the endotheque (and ectotheque ?) of an intra-capsular sporosac through the summit of the capsule.

2. That in certain other species (*Campanularia flexuosa*, &c.) the final development of the ovum, previously to liberation, takes place in a peculiarly formed medusa-like *extra-capsular sporosac*, which, however, must not be confounded with a true medusal zooid. It originates as an ordinary intra-capsular sporosac, and subsequently becomes extra-capsular by the elongation of the blastostyle.

The most important steps in the development of the true medusal buds are the following:—

(1.) The formation of a hollow process from the cœnosarc or blastostyle. (2.) The differentiation in this process, of a peripheral portion (ectotheque), and a central portion (manubruim); the latter becoming further differentiated into two layers, ectoderm and endoderm. (3.) The emission from the hollow central portion of four cœcal tubes (radiating canals), composed of ectoderm and endoderm, which, simultaneously with their elongation, have their ectodermal layer expanded into a web-like membrane (umbrella), connecting the tubes laterally with one another. (4.) The further connection of the radiating tubes with one another by lateral branches (circular canal), and the development of a velum from the margin of the umbrella.

From the above processes, it follows that the development of the medusa admits of an easy comparison with that of the alimentary polype, the radiating canals being developed from the central manubrium in the medusa, exactly as the tentacula are from the body of the polype; but that, while in the polype they continue free, in the medusa they are united laterally by an extension of the ectoderm and by lateral branches.*

A comparison of the two kinds of reproductive zooids (sporosacs and medusa) and of the alimentary zooid (polype) results in the following parallelism:—

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* In the remarkable species, *Laomedea acuminata* (Alder), the tentacles of the polype are actually united, as Mr Alder has shown, for a considerable distance from their origin, by an intervening membrane.

Madras Journal of Literature and Science. Vol. III., No. 6. 8vo. —*From the Madras Literary Society.*

The Atlantis: A Register of Literature and Science. No. 2. 8vo. —*From the Editors.*

Proceedings of the Academy of the Natural Sciences of Philadelphia. From April 7, 1857, to April 27, 1858. 8vo.—*From the Academy.*

Notice of some Remarks by the late Mr Hugh Miller. By Mr W. P. Foulke. 8vo.—*From the Author.*

Reports on the Meteorology of Scotland for 1857. 8vo.—*From the Meteorological Society.*

Address to the Meteorological Society of Scotland. By Jas. Stark, M.D. 8vo.—*From the Author.*

Translation from the Dutch Pamphlets on Herring Fisheries. 8vo. —*From Dr Hunter.*

Journal of the Asiatic Society of Bengal. Nos. 264, 266, and 267. 8vo.—*From the Society.*

History of Scientific Ideas. By Wm. Whewell, D.D. Vols. I. and II. 8vo.—*From the Author.*

Canal and River Engineering. By David Stevenson, F.R.S.E. 8vo.—*From the Author.*

Notes on the prior Existence of the Castor Fiber in Scotland. By Charles Wilson, M.D. 8vo.—*From the Author.*

Reports of Continental Children's Hospitals. 8vo.

A Treatise on Light, Vision, and Colours. By Thos. Bett, Esq. 8vo.—*From the Author.*

Der Naturen Bloeme, van Jacob van Maerlant. 8vo.

Rhymbal von Jacob van Maerlant: Erste Deel. 8vo.

Bulletin de la Société Impériale des Naturalistes de Moscou. Nos. 1 to 4. 8vo.—*From the Society.*

Compte Rendu de l'Académie Impériale des Sciences de St Petersbourg. 1856. 8vo.—*From the Academy.*

Mittheilungen der Naturforschenden Gesellschaft in Bern. Nos. 360 to 407. 8vo.—*From the Society.*

Verhandlungen der Schweizerischen naturforschenden Gesellschaft in Basil. 1856. 8vo.—*From the Society.*

Bulletin de la Société Vaudoise de Sciences Naturelles. Tome V. Bulletins 41 et 42. 8vo.—*From the Society.*

Bulletin de la Société de Geographie, Paris. Tomes 14 et 15. 8vo.—*From the Society.*

Verslagen en Mededeelingen der Köninklijke Akademie van Wetenschappen, Amsterdam. Afdeeling Natuurkunde, Deel VII. 8vo. Afdeeling Letterkunde, Deel III. 8vo.—*From the Academy.*

Variations Annuelles et Horaires des Instruments Météorologiques a Bruxelles. Par M. Quetelet. 8vo.—*From the Author.*

Observations des Passages de la Lune et des Étoiles de même culmination. Par M. Quetelet. 8vo.—*From the same.*

Composition de l'Atmosphère. Par M. Lamont. 8vo.—*From M. Quetelet.*

Rapport sur l'Etat et les Travaux de l'Observatoire Royal, pendant l'Année 1856. Par M. Quetelet. 8vo.—*From the same.*

Eclipse de Soleil du 15 Mars 1858. Par M. Quetelet. 8vo.—*From the same.*

Catalogues van de Bockerij du Koninklijke Akademie van Wetenschappen, Amsterdam. Deel I. 8vo.—*From the Academy.*

Jaarboek van de Koninklijke Akademie van Wetenschappen, Amsterdam. 1857–8. 8vo.—*From the same.*

Bibliografia Italiana delle Scienze Mediche Serie Prima. Vol. Primo. 8vo.

Rendiconto delle Sessioni dell' Accademia delle Scienze dell' Istituto di Bologna. 1855–6. 8vo.—*From the Academy.*

Die Fortschritte der Physik in Jahr, 1855. Dargestellt von der Physikalischen Gesellschaft zu Berlin. 8vo.—*From the Society.*

Jahresbericht ühn die Fortschritte der reinen, Pharmaceutischen und technischen Chemie, Physik, Mineralogie, und Geologie.—Chemie und verwandter Theile anderen Wissenschaften von Hermann Kopp und Henrich Will.—Physik von Fredrich Zamminer. Für 1857. Register zu den Berichten für 1847 bis 1856. 8vo.—*From the Editors.*

Publications of the Dépôt Général de la Marine:—

- Collection of Charts.
- Erreurs des compas dues aux attractions locales a Bord des Navires en Bois et en Fer. Par M. Darondeau. 8vo.
- Supplement au Catalogue Chronologique des cartes. Plans, Vues de Côtes, &c. 8vo.
- Manuel de la Navigation dans le Detroit de Gibraltar. Par Dumolin et de Kerhallet. 8vo.

Reconnaissance Hydrographique des Côtes occidentales du Centre Amerique, Province de Veraquas (Nouvelli Grenada). Par M. De Rosencoat. 8vo.

Note sur les Courants de l'Ocean Atlantique entre l'Equateur et le 10^e degré de latitude N. Par M. Lefebvre. 8vo.

Supplement au Livre des Pharas. Par M. Le Gros. 8vo.

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Notes sur la Navigation de L'Archipel des Marquises. Par M. Jouan. 8vo.

Instruction a Levivre pour allier mouller sur la Rade de Santa Cruz. 8vo.

Annuaire des Maries des Côtes de France, pour 1858. Par M. Chazallon. 32mo.

Annaes des Sciencias e Lettras publicados debaixo dos auspicios da Academia Real das Sciencias.—Sciencias Mathematicas Physicas, Historico-Naturaes, e Medicas. Vol. I., Nos. 1–7. Sciencias Moraes e Politicas, e Bellas Lettras. Vol. I., Nos. 1–5. Noticias para a Historia e Geografia das Nações Ultramarinas. Tomo VI. 8vo.—*From the Academy.*

Berichte über de Verhandlungen der Königlich Sächsischen Gesellschaft der Wissenschaften zu Leipsig. Philologisch Historiche Classe. 1856, III. and IV.; 1857, I. and II.; 1858, I.—Mathematische, Physiche Classe. 1857, II. and III.; 1858, I. 8vo.—*From the Society.*

Bulletin de l'Academie Royale de Belgique. II. Series. Tomes I., II., and III. 8vo.—*From the Academy.*

Mémoires Couronnés et Autres Mémoires. Tome VII. Publies par l'Académie Royale de Belgique. 8vo.—*From the same.*

Annuaire de l'Académie Royale de Belgique. 1858. 8vo.—*From the same.*

Annuaire de l'Observatoire Royal de Bruxelles. Par M. Quetelet. 1858. 32mo.—*From the Author.*

Annales de l'Observatoire Royal de Bruxelles. Par M. Quetelet. Tome XII. 4to.—*From the same.*

Observations des Phénomènes Periodiques. 4to.—*From the same.*

Jahrbuch du Kaiserlich-Koniglichen Geologischen Reichsanstatt. Wien. 1857. N^{ro}. 2, 3, and 4. 8vo.—*From the Institution.*

Monatsbericht der Königlichen Preuss. Akademie der Wissenschaften zu Berlin. Januar, Februar, März, April, Mai, Juni, 1858.—*From the Academy.*

Geological and Topographical Map of London and its Environs. By R. W. Milne, F.R.S. 8vo.—*From the Author.*

Collection of Maps of the Basin of La Plata, &c. By Thomas J. Page, U.S. Navy.—*From the Author.*

Explanations and Sailing Directions to accompany the Wind and Current Charts. By M. F. Maury, LL.D., U.S. Navy. Vol. I. 4to.—*From the Author.*

Report of Progress 1853–56 of Geological Survey of Canada. 8vo. —*From Sir W. E. Logan.*

Plans of Lakes and Rivers between Lake Huron and the River Ottawa, to accompany the Geological Reports. 4to.—*From the same.*

Memoirs and Papers of Hugh E. Strickland, M.A. By Sir W. Jardine, Bart. 8vo.—*From the Author.*

Astronomical and Meteorological Observations made at the Radcliffe Observatory, Oxford, in 1856. Vol. XVII. 8vo.—*From the Radcliffe Trustees.*

Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft für die gesammten Naturwissenschaften. Zurich. Band XV. 4to.—*From the Society.*

The Habeeb-os-Seear. By Mirza Gheeos-od-Deen bin Mirza Hamaeem-od-Deen. Being a General History of the World from the Earliest Times to the Year of the Hijira 930., A.D. 1520. 2 vols. 4to.—*From* ALI MUHAMMED KHAN, *Consul of the Ottoman Porte at Bombay.*

Compte-Rendu Annuel. Par A. T. Kupffer. Année 1856. 4to.—*From the Author.*

Memorie della Reale Accademia delle Scienze de Torino. Tome XVII. 4to.—*From the Academy.*

Sulle Forme Cristalline di Alcuni Sali di Platino e del Boro Adamantino. Per Q. Sella. 4to.—*From the Author.*

Sulle Forme Cristalline del Boro Adamantino. 2do. Memoria. Per Q. Sella. 4to.—*From the same.*

List of Members, Report of Council, &c., of the Royal Institute of British Architects. 1858. 4to.—*From the Institute.*

Verhandlingen du Koninklijke Akademie van Wetenschappen. Amsterdam. Deels. IV, V., and VI. 4to.—*From the Academy.*

Flora Batava. Part 183. 4to.—*From the King of Holland.*

Observations on the Genus Unio. By Isaac Lee, LL.D. Vol. VI. Part I. 4to.—*From the Author.*

Judicial Statistics, 1857, England and Wales.—Police, Criminal Proceedings, Prisons; Common Law, Equity, Civil and Common Law. 4to.—*From the Secretary of State for the Home Department.*

Meteorological Tables of the Board of Trade. Nos. I., II., and III. 4to.—*From the Board.*

Report on the Meteorological Department of the Board of Trade. 1858. 8vo.—*From the same.*

Barometer and Weather Guides. By R. Adon. Fitzroy. 8vo.—*From the same.*

Transactions of the Society of Antiquaries of London. Vol. XXXVII., No. 2. 4to.—*From the Society.*

Proceedings of the Society of Antiquaries of London. Vol. IV., No. 47. 8vo.—*From the same.*

List of Members of the Society of Antiquaries of London for 1858. 8vo.—*From the same.*

Observations Météorologiques Faites à Nijné-Taguilsk. Resumé des Dix Années 1845–54; et Année 1855; et Année 1856. 8vo.

Danzigs Handels und Gewerbsgeschichte unter dur Herrschaft des Deutschen Ordens. Von du Theodor Hirsch. 8vo.—*From the Royal Saxon Society of Science of Leipsic.*

Elektrische Untersuchungen. Zweite Abhandlung: über die Thermo-Elektrischen Eigenschaften des Boracites. 1857. 8vo.—*From the same.*

Elektrische Untersuchungen. Dritte Abhandlung: über Elektricitäts; erregung Zwischen Metallen und erhitzten Salzen. 1858 8vo.—*From the same.*

Nouveau Principe sur la Distribution des Tensions dans les Systèmes Élastiques. Par M. L. F. Ménabria. 4to.—*From the Author.*

Archives de Museum d'Histoire Naturelle. Tome X. Liv$^{\text{ons}}$ I. et II. 4to.

Den Magnetische Inclinations Forandringer i den Nordlige og Sudlige Halvkugle. Af Christopher Hansteen. 4to.—*From the Author.*

Astronomical, Magnetical, and Meteorological Observations made at the Greenwich Observatory. 1856. 4to.—*From the Royal Society.*

Magnetical and Meteorological Observations made at Bombay Observatory. 1856. 4to.—*From the East India Company.*

Abhandlungen du Königlichen Gesellschaft du Wissenschaften zu Göttingen. Band VII. 1856–7.—*From the Society.*

Abhandlungen du Königlichen Akademie du Wissenschaften zu Berlin. 1857.—*From the Academy.*

Compendio Storico della Scuola Anatomica di Bologna. Scritto da Michele Medici. Folio.—*From the Author.*

Rendiconto della Societa Reale Borbonica. Anno V. 4to. Napoli.—*From the Society.*

Memorie della Reale Accademia delle Scienze. Napoli. Vol. I., 1852–54; Vol. II., 1855–57. 4to.—*From the Academy.*

Account of the Principal Triangulation, and of the Figure, Dimensions, and Mean Specific Gravity of the Earth, as derived therefrom. By Captain A. R. Clarke, of the Ordnance Survey. 4to.—*From the Secretary of State for War.*

Details au Sujet de la Formation des Oolites Calcaires. Par M. J. Fournet. 8vo.—*From the Author.*

Index Map to the Ordnance Survey of England and Wales.—*From the Board of Ordinance.*

Compte-Rendu de l'Académie Imperiale des Science de St Petersbourg. 1857.—*From the Academy.*

Abhandlungen, Herausgegeben von der Senkenbergischen Naturforschenden Gesellschaft. Band II., Lief. 92.—*From the Society.*

Engravings of the Ganglia and Nerves of the Uterus and Heart. By Robert Lee, M.D., F.R.S. 8vo.—*From the Author.*

Proceedings of the Royal Geographical Society of London. Vol. II., No. 6. 8vo.—*From the Society.*

Transactions of the Cambridge Philosophical Society. Vol. X., Part I. 8vo.—*From the Society.*

Monday, 20th December 1858.

Professor CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. On the First Properties of Matter—Inertia, Gravitation, Elasticity—referred to a common Law. By John G. Macvicar, D.D. Communicated by Professor Fraser.

The author commences by a vindication of the Scottish philosophy, that he may legitimately build upon *substance* as a reality as well as *phenomenon*. He then shows that just as the idea of substance presents, *a priori*, an alternative, viz., those which are wholly fixed, the subject of law imposed from without only, and those which possess a power of changing their mode of being from within themselves; so, in point of fact, common observation has recognised in all ages two orders of substances or beings characterized by this difference, and filling up in the sphere of reality this alternative given by pure thought; the one being the ground of all natural phenomena, and ordinarily designated *body;* the other the ground of all moral and intellectual phenomena, and designated *spirit.*

Of Body the most characteristic properties are inertia, gravitation, and elasticity; and these are still regarded in science merely as postulates, and that, unrelated to each other except as properties inhering in the same subject; just as heat, electricity, magnetism, and chemical affinity were some years ago. It is the attempt to show the homogeneity of this group of properties, and to account for them, that has given its title to this communication.

For this purpose the author lays hold of *The Law of Assimilation*, already admitted in physiology; he shows that it operates in nature far more extensively than is generally supposed; in fact, he affirms that it is universal, and the only law of nature that needs to be considered by us for the explanation of phenomena. This law, when thus conceived in its utmost generality, he thus expresses:—"Everything *tends* to assimilate itself to itself in successive moments of its existence; and *extends* this action to all things around to unknown distances, assimilating them also more or less to itself, meanwhile being of course more or less assimilated to them in its turn." And hence, all through nature, at once the permanence and intransmutability of species, whether organized or molecular, and the construction of these species into genera or groups into which the same type enters.

His first application of this law is to show the genesis of inertia. Thus, let any portion or particle of substance considered merely as such be subject to this law alone, it follows, that in its relations both to space and time, that portion or particle must assimilate itself to itself in every successive moment; that is, if it be at rest it must continue at rest, and if it be in motion it must, in every successive moment, accomplish the same element of motion which it accomplished in the first; whence it is obvious that its motion must be uniform and rectilinear, and must continue so till it be changed from without. But this is simply a definition of inertia, whose genesis thus appears.

Similarly he shows, that if the portion or particle of substance be considered, not in reference to its *matter* but its *form*, it must, under the law of assimilation, tend to maintain its true volume and form, and, to restore it when it has been disturbed—it must be resilient and elastic.

Again, let there be two or more particles or masses (each and all of which must thus be inert, and in their last elements elastic also), and let them be placed in different regions of space; it follows, that though as to inertia and elasticity they are identical already, and the law of assimilation has exhausted itself upon them as substances and forms, yet they are not assimilated as to the spaces they occupy. This, therefore, the law of assimilation must tend to effect. Under this law they must tend towards one place. Moreover, in being assimilated as to place, they must also be assimilated as to time. In a word, they must tend to move, and that simultaneously, towards one another, each assimilating the other as to the place which it occupies, or attracting it with a force proportional to itself (its quantity of substance, mass, or inertia). Nor is it merely the fact of mutual attraction that follows from the law of assimilation, but also the law of that attraction. Thus, considered as an attractive apparatus, it must be conceived as investing in a spherical manner the attracting particle. Now, the law of assimilation requires, with respect to such a spherical investiture, that all the successive spherical shells or superficies, of which the entire sphere of attraction may be conceived to consist, must in attractive value be assimilated to each other; that is, they must all be equal to each other. But in quantity or extent they vary as the squares of their distances from the centre. Estimated, therefore, not as to the entire superficies, but along any line or radius, the attractive force must vary inversely as the square of the distance or radius; which is the well-known law of gravitation. Thus the genesis at once of inertia, elasticity, and gravitation is given. They are shown to be homogeneous in their nature, and not occult properties inhering in matter, but merely uniform phenomena arising from the operation in different circumstances of one and the same law.

The author then proceeds to show, that the law of assimilation also gives a definite conception as to the structure of least parts of matter in the last analysis which nature appears to permit or accomplish. He is thus led to infer the existence of an universal ether or medium of light. And from this, to the molecules of bodies, he thinks that a transition may be made, by regarding the latter as products of the former; the ethereal elements being definitely grouped into molecules; which, under the law of assimilation, must be symmetrical, and permanent or intransmutable (except in long epochs), as also ever bent on union with one another, wherever there is a difference between them; and their union would not occasion too great a degradation of the symmetry which each possessed when existing separately.

2. On the Structure and Functions of the Branchial Sac of the Simple Ascidiæ. By Andrew Murray, Esq.

The chief portion of this paper is occupied with an inquiry into the truth of Milne Edwards' theory, that the branchial sac of the Ascidians is perforated throughout by apertures, or what he called branchial stigmata.

Some experiments and observations made by Mr Murray last season had induced him to regard this view with doubt. In considering the question, he first examined the evidence that was recorded in support of it. Putting aside those writers who had taken M. Edwards' theory on trust, he could only find four observers who seem to have critically tested it, viz.,—Dr Lister, with whom the idea originated: who, while stating that the walls of the sac appeared to be traversed by open spaces, yet states that at times he thought he saw something like a veil stretching across them, and that the particles in suspension in the water were observed to course past these spaces without entering; which would appear to be inconsistent with the idea of the water entering, for the course of the water, and of the particles floating in it, must necessarily be the same. The next author was Milne Edwards, who announced the open passages as a fact, without going into any reasoning or proof upon it. He however started with a bias; for he alludes at the outset to Dr Lister having established the fact, which, it will be observed, is stating the results of his observations much too strongly. M. Coste followed, and took the directly opposed view, holding that the branchial spaces were all closed by a more or less diaphanous membrane. Van Beneden seems to have halted between the two opinions. But Huxley, the last and most formidable of them all, takes Edwards' idea up *in toto*, and has informed Mr Murray, that he thinks he has seen the currents of water passing through the stigmata in at least two *Ascidiæ*, viz., *Perophora*, and *Appendicularia*.

Mr Murray's observations consisted in feeding the Ascidiæ with coloured sea water, in injecting them, and in actual examination of their structure. In those fed with indigo, the coloured material was never found on the exterior of the sac, but always deposited on its inner wall. Injection by the mouth into the sac failed to push the injection through its walls except by rupturing them. Mr Murray thought that, under a high power of the microscope, a diaphanous membrane was to be seen stretching across the branchial stigmata; but if so, the membrane was so thin as to be scarcely perceptible.

According to Mr Murray, the mode in which the water which enters at the oral aperture passes to the anal aperture would therefore appear to be still unknown.

Mr Murray narrated, also, his dissections of the ciliated sac or valvular aperture which lies at the top of the dorsal fold, which at one time he had been disposed to think (with the elder Carus) might furnish a mode of egress, but satisfied himself that it was rather a blind sac, or at least a sac terminating in a very small blood-vessel.

In the course of his investigations Mr Murray made the curious discovery, that in *Phallusia Virginea* the chylaqueous fluid is strongly acid. He had not found this quality in any other species which he had yet examined, but he thought it probable it might be found in *P. Mentula*, *P. Oblonga*, and those other species which are allied to *P. Virginea.*

Another observation made by Mr Murray in relation to this matter, and one which promises to furnish interesting results, was, that in none of the mollusca (and indeed in none of the invertebrate animals) on which his experiments had been made, was the food digested by gastric acid. He had never found acid in the stomach. The mode of digestion in the invertebrata would appear therefore to be probably conducted on a different system from that in the vertebrata.

Incidentally Mr Murray alluded to the Notodelphs and small crustacea found in the stomachs of Ascidiæ. He differed from those authors who thought them parasitic, as he had found many dead, and in all stages of apparent digestion, in the respiratory sac of *Phallusia Virginea.*

With regard to the homology of the parts in question, he pointed out that the facts he had brought forward all tended to show that the sac is homological with the pharynx rather than with the tentacular crown of the Polyzoa.

The following Donations to the Library were announced:—

Quarterly Journal of the Chirurgical Society, No. XLIII. 8vo.—*From the Society.*

Bulletin de la Société Impériale des Naturalistes des Moscou. 1857, Nos. II., III., and IV. 1858, No. I. 8vo.—*From the Society.*

Transactions of the Pathological Society of London. Vol. IX. 8vo.—*From the Society.*

Schriften der Universität zu Kiel. 1856, Band III. 1857, Band IV. 4to.—*From the University.*

Journal of the Statistical Society of London. Vol. XXI. Part IV. Dec. 1858. 8vo.—*From the Society.*

Memoirs of the Literary and Philosophical Society of Manchester. Vol. XV. Part I. 8vo.—*From the Society.*

Proceedings of the Literary and Philosophical Society. 8vo. Nos. 1 to 14. 8vo.—*From the same.*

Eight Maps of Hindostan. Nos. 24, 38, 54, 73, 102, 103, 111, and 112.—*From the East India House.*

An Account of Some Recent Researches near Cairo, undertaken with the view of throwing light upon the Geological History of the Alluvial Land of Egypt. Instituted by Leonard Horner, Esq. 4to.—*From the Author.*

Proceedings of the Zoological Society of London, 162 to 169. 8vo. —*From the Society.*

Transactions of the Zoological Society of London. Vol. IV. Part V. 4to.—*From the same.*

77 New Charts, 4 Corrected Charts, and 15 Books and Pamphlets. —*From the Admiralty.*

Notice of two new Maximum and Minimum Thermometers, by the Rev. J. G. Macvicar, D.D. of Moffat.—*From the Author.*

Monday, 3d January 1859.

Professor KELLAND, Vice-President, in the Chair.

The following Communications were read:—

1. Note on certain Vibrations produced by Electricity. By Professor Forbes.

"In the course of last summer (1858) I became acquainted with a phenomenon described by Mr Gore in the Philosophical Magazine for June (Supplement, p. 519), of the following nature:—A metal cylinder, supported on two metallic rods or rails, the latter being in connection respectively with the poles of a battery, revolves in either direction, at will, under the action of an electric current copious in quantity. Also continuous rotation of a light copper ball, supported on two circular metallic rails, takes place in either direction at pleasure, depending on the first impulse. It appeared to me very probable that this interesting fact might be applied to explain what is still obscure in the experiment on heated metals, generally known as the "Trevelyan Experiment," described by Mr Trevelyan, in the "Edinburgh Transactions," vol. xii., where there is also a paper by myself on the same subject. With a view to elucidate the experiment, I had Mr Gore's circular railway and ball constructed some months since by Mr Kemp. I had not an opportunity of seeing it tried until October 19th, when I found it to answer well, with four

Bunsen's pairs connected for quantity. The same day, in Mr Kemp's laboratory, I laid a brass "Trevelyan" bar or rocker on the edge of the brass plate, forming the outer rail of Mr Gore's machine, and connecting the rail with one pole of the same battery, and the bar (by means of a globule of mercury inserted in a cavity in its upper surface) with the other, energetic vibrations commenced quite resembling those occasioned by heat in the ordinary form of the experiment on a leaden support.

"I have since found, among other results,—1. That the vibration goes on in whichever direction the electric current passes. [At first I thought that there was a superior effect when the current passed from a good to an imperfect conductor, but this has not been confirmed, as far at least as I have gone]. 2. The vibrations take place both between metals of the same kind and heterogeneous metals. 3. When heat is applied to a brass bar vibrating on cold lead, and then electricity is applied as before, the effects are superadded to one another whichever way the current passes, the vibrations becoming more energetic, and if there be a musical note it becomes graver [owing, it is assumed, to the increased arc of vibration]. 4. When a bar of brass was placed so as to vibrate on two parallel upright plates, also of brass, respectively connected with the poles of a battery, the vibrations continued, when the whole was immersed partly or wholly in water, and even when *flooded* by a powerful continued stream of cold water from a five-eighth inch pipe under considerable pressure. From this experiment I conclude that the effect of the heat developed by the electrical current in the thin upright plates may be fairly considered to be reduced so low as to be incapable of producing a sensible result (if such were ever the case). Indeed, allowing for the resistance and friction of the water tending to diminish the vibration, there is no ground for thinking that the action was less energetic in the one case than in the other. It is consequently reasonable to conclude that the effect in question is due to the repulsive action of the electricity in passing from one conducting body to another, and not to its effect in producing expansion.

"Now this is precisely the effect which I attributed to heat in the paper of 1833 already referred to. I therefore consider it a strong confirmation of the opinion I then expressed, from which I have never swerved, although it has not in general been received with much favour. The importance which I attach to this new confirmation, and the suggestiveness of Mr Gore's experiment on the rolling-ball, will be judged of from the fact, that in 1833, or earlier, I had an apparatus made, consisting of a bar resembling Mr Trevelyan's, but longitudinally divided by a non-conducting partition, while the two conducting sides were furnished with mercury cups for connecting them with the poles of a battery, the circuit being completed through the metallic base. The instrument exists, or existed a few years ago, though I am at present unable to find it. As well as I recollect, it was tried with an old-fashioned Cruickshank's battery of fifty pairs, without success. Indeed, I now find that, even with modern appliances, the experiment does not succeed when the circuit is only closed whilst *both* points of bearing of the rocker touch the mass or support.

" 20th December 1858."

" Since the date of the preceding notice (which was prepared for being laid on the table of the Royal Society at their meeting on the 20th ult.), I have continued and extended these experiments. As they are still in progress, I will content myself with mentioning two results as worthy of notice. I have obtained very active vibrations of carbon (such as is used in one of the elements of Bunsen's battery) resting upon brass, and also when it rests upon two pieces of carbon connected with the terminals of a battery. For this purpose, a battery having a certain amount of intensity is requisite, in order to overcome the resistance of carbon as a conductor, but the vibrations are most energetic. The extremely small expansion which takes place in carbon by heat is another argument against that view of the Trevelyan experiment. The other experiment to which I refer is, that bismuth (and perhaps other metals) are not merely inactive as vibrators with any electric power which I have used, but the passage of electricity through them appears to have a *quelling* power which brings the rocker to instantaneous rest; yet bismuth permits a far freer passage of electricity than carbon: in one experiment I found that sixteen times as much was conducted. Something analogous was formerly observed by me in connection with heat applied to bismuth. I am now attempting to investigate the subject farther by experiment.

" 3d January 1859."

2. On the Temperature of the Sea around the Coasts of Scotland during the years 1857 and 1858; and the bearing of the facts on the Gulf-stream Theory. By James Stark, M.D., F.R.S.E., &c.

By a reference to observations made on the temperature of the air, of the sea, and the solid land, the author showed that the mean temperature of each of these in and around Scotland were within the fraction of a degree of each other. From observations made on the temperature of the air and of the sea at stations on the west coast, he showed that not only did the air and sea attain their respective minima and maxima at the same time, but that even in their fluctuations of temperature they bore a distinct accord with each other. He then pointed out that such fluctuations in the temperature of the sea were quite fatal to the theory of the mild winters of Britain being dependent on the influence of the Gulf-stream, as such fluctuations could not occur were the temperature of the sea dependent on the heated waters of the Gulf-stream. From a variety of considerations he therefore endeavoured to demonstrate that the mild winters of Britain were due to the south, south-west, and west winds, which are the prevalent aerial currents which pass over Britain during the winter season.

He then examined the whole evidence brought forward by Maury and others for the Gulf-stream flowing up through the North Atlantic to Britain and the North Seas, and by a reference to a number of well ascertained facts, demonstrated that the Gulf-stream has no such course; but that, on the other hand, it is, on the east of the great Newfoundland Bank, deflected southwards by the great Arctic current, and is lost in that great calm mass of waters, the Sargasso Sea, which exists in the centre of the Atlantic.

He then pointed out the course of the currents in the North Atlantic Ocean. He showed that though a small portion of the Arctic current flows through the Gulf of St Lawrence, while another portion flows towards the American coasts, washing the southern shores of Newfoundland and Nova Scotia, that the chief portion of that current crosses the Atlantic towards the western shores of Europe and Africa. That the upper part of this current entering the Bay of Biscay, washes round it, giving rise to the current known as Rennell's current, which as it leaves the Bay of Biscay crosses the mouth of the English Channel, and flows up both sides of Ireland. That the middle portion of the Arctic current flows through the Straits of Gibraltar to supply the wastes in the Mediterranean Sea. And that the southern, and probably the greater portion of this Arctic current, rushing towards the north-west coast of Africa, gives rise to that current so much dreaded by mariners, and known by the name of the North African current.

He then showed that neither the Gulf-stream, nor any other current in the North Atlantic, took their direction in consequence of any influence of the rotation of the earth on its axis; and pointed out the fact, that the direction of the equatorial current, of the Gulf-stream as it issues from the Gulf of Florida, and of the Arctic current as it crosses to Western Europe and Africa, are all opposed to such a supposition.

He also showed that the Gulf-stream is bent back on the curved coasts of Florida by the greater force of that portion of the Equatorial current which flows to the north of St Domingo and Cuba, and meeting the smaller stream which issues from the Gulf of Mexico, forces it back on the Florida coast. He also showed that the eastward course of the Gulf-stream was given by the curved coasts of Florida, Georgia, and the two Carolinas.

The author then referred to Commander Becher's bottle-chart as fully corroborating his views of the course of the currents in the North Atlantic, and pointed out many facts, proved by that valuable chart, which were quite opposed to and inexplicable by the theory that the Gulf-stream flows onwards towards Britain.

The different specific gravities of the Arctic current and of the Gulf-stream, the density of the sea-water on our western shores during summer and winter, the existence of the telegraph plateau between Newfoundland and Ireland, the finding in the mud brought up from it volcanic ashes identical with those from Iceland, and the known limits of the whalebone and spermaceti whales, were all referred to as corroborative of the views of the author.

Dr Stark then summed up by showing the bearing of all the facts he had stated on the question as to what caused the mildness of Britain's winters, and showed that they all corroborated the conclusion that the south-west winds were the agents by which this was effected. He showed that the only countries of Europe which could be materially benefited by these winds were the south of Spain, Portugal, Britain, and Norway; while France, from lying far back, with the whole peninsula of Spain intervening between these winds and her, experienced to but a trifling extent their heating properties, and consequently, though much further south, had a winter more severe than that in Britain.

The following Gentlemen were duly elected Ordinary Fellows of the Society:—

WILLIAM F. SKENE, Esq.
G. W. HAY, Esq.
ROBERT RUSSELL, Esq.
Dr FAYRER.
GEORGE ROBERTSON, Esq.
Dr LYON PLAYFAIR, C.B.

The following Donations to the Library were announced:—

The Lithology of Edinburgh, by Rev. John Fleming, D.D., F R.S.E. With a Memoir by the Rev. John Duns, Torphichen. 8vo.—*From the Publisher.*

Annales de l'Observatoire Physique Central de Russie. Anna 1855. Nos. 1 and 2. 4to.—*From the Russian Government.*

Medico-Chirurgical Transactions. Vol. xli. 8vo.—*From the Royal Medical and Chirurgical Society of London.*

Journal of Agriculture and Transactions of the Highland and Agricultural Society of Scotland. No. 63. 8vo.—*From Highland Society.*

Nyt Magazin for Naturvidenskaberne. Udgives af den physiographiske Forenung i Christiania ved M. Sars og Th. Kjerulf. Tiende Binds förte Heft. 8vo.—*From Royal University of Norway, Christiania.*

Norges Historie i Kortfattet Udtog af P. A. Munch. Fierde Udgave. 8vo.—*From the same.*

Gamle Norske Folkeviser Udg. af Sopus Bugge. 8vo.—*From the same.*

Kortfattet Beiledning af M. G. Fletting. 8vo.—*From the same.*

Norges Gamle Love, indtil 1387. Ved R. Keyser og P. A. Munch 1, 2, and 3 Binds. Folio.—*From the Royal Society of Drontheim.*

Det Norske Sprogs vaesentligste Ordforrand Sammenlignet nud Sanskrit, &c. Af Chr. A. Holmboc. 8vo.—*From the same.*

Monday, 17th January 1859.

PROFESSOR CHRISTISON, Vice-President, in the Chair.

The following Communications were read:—

1. Notice of a Shower of "a Sulphurous Substance" (so-called), which fell in Inverness-shire in June 1858. By John Davy, M.D., F.R.S., London and Edinburgh, &c.

This shower took place about the 10th of June. The following account of it is from the *Inverness Courier;* and, as showing the interest the phenomenon excited, it was republished in most of the English papers. The copy I give is from the *Spectator* of the 3d July.

"After the late thunder-storm, a deposit resembling sulphur was observed in several places in this neighbourhood (Inverness). At Freeburn it lay on the road and grass in some places to a depth of nearly half an inch. At Craigton Cottage, near Kissock, the deposit was observed on the top of water caught in a cask from the roof of the house, like a thick cream. The sulphurous substance was skimmed off, and dried in a piece of flannel. When dry it was a fine powder, and when thrown into the fire ignited exactly like gunpowder, making a slight fizzing noise. Unfortunately none was preserved beyond what was experimented on in this way. A boat at Craigton was powdered all over with the same substance; and a countryman living on the heights near Kilmuir, says, that near his house, in the space of what an ordinary washing-tub would cover, he could lift the powder with a spoon. The heavy rains have since washed it all away."

This account, so far as mere appearances are concerned, I believe to be trustworthy; I can in part confirm it, as it happened that on the very day, the 10th of June, I was *en route* for Inverness by the mail, proceeding by the upper Highland road. Just after crossing the Spey at Kingussie, the substance in question was seen, both on the road and by the road-side. It was in such abundance that the guard had no difficulty in collecting a quantity of it during the few seconds that the coach was stopped for the purpose. Of what was then gathered I obtained a portion, which, on my return home, I examined.

The results, as might be expected, proved that the substance was not sulphur, nor of a sulphureous nature, but a vegetable matter, the pollen of the fir—*Pinus sylvestris*, a tree of which there are extensive forests on the banks of the Spey. Before the blow-pipe, it burnt with flame, without the slightest sulphureous odour; and left a little charcoal, which, when consumed, yielded a minute quantity of ash, possessed of an alkaline reaction. When first inflamed it made no such noise as that mentioned in the newspaper; nor in burning did it in the least resemble gunpowder. If thrown on the fire before it was quite dry, the noise described in that notice might have been owing to the sudden conversion of the moisture into steam, producing a slight crepitation. Under the microscope it was found to consist of grains, some of a spherical form, others, and those of largest size, of the same form, with, as it were, a lateral addition, as if a smaller grain were attached, or as if the pollen grain had been ruptured at opposite points, and a protrusion of some of its contents had taken place.* The diameter of a single grain was about $\frac{1}{1070}$th of an inch. The central part of those supposed to be ruptured was commonly transparent, and exhibited a delicate granular structure, which was rendered slightly brown by the action of iodine. The lateral protuberances were more or less opaque.

Comparing the substance under consideration with the pollen of the Scotch fir, taken fresh from the tree, I find there is a perfect resemblance in form and colour and other properties. Further, in corroboration, it may be mentioned, that at the time of the occurrence of the shower, this fir was in flower in the Highlands very generally; and it is well known that when ripe, as it was at the time specified, it is apt to be shaken off by gusts of wind and rain in extraordinary quantities, so as to produce what have been called "sulphur-showers." By Sir John Richardson I have been informed that it is not uncommon to see the surface of the great lakes in Canada covered with a thick scum of the same kind in the vicinity of pine forests.

What renders the event, as it took place in the Highlands, re-

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* In the pollen of the Scotch fir we find, that by the increase of the intine the extine is separated into two hemispherical portions, marked by the dark spaces at each end of the grains.—*Edit. R. S. Proc.*

markable, and no doubt rare there, is the extent of ground over which the pollen fell, and the quantity of it that was deposited.* It is worthy of notice, that this year the flowering of all our plants has been astonishingly abundant. This circumstance may account for the quantity; and the rareness of the phenomenon may be owing to the circumstances essential to its taking place seldom coming together, such as the incident of a thunder-storm with rain just at the time that the pollen is ripe for dispersion.

In the annals of the dark ages showers are recorded of a singular kind: in those of Ireland, for instance, as detailed in the last valuable census of that country, mention is made of those "of blood," of "a butter-like substance," &c.; and, analagous to that in Inverness-shire, "of a shower of a yellowish substance which resembled brimstone." This last mentioned is recorded as having "fallen in and about the town of Doneraile," in 1748.

In conclusion, I would beg to observe, that I have been particular in the account of this pollen shower, with the hope of showing that an occurrence vaguely reported, assuming, from the manner in which it has been described by eye witnesses, a perplexing and mysterious character, when examined with the smallest aids afforded by science, loses those qualities, and appears perfectly natural. And, I would add, can it be doubted, that had other showers, such as the reported ones of blood, &c., been in the same manner investigated, the result would have been similar; and in the place of a marvel, we should have had recorded an interesting, and it may have been an instructive fact. Such phenomena might perhaps, in particular cases, serve a part to the naturalist akin to that of coins and other remains of art to the antiquarian, and lead to inferences in the science of the former hardly less certain and valuable than those derivable from the latter in civil history. I venture to give an instance in illustration. After finding the substance in question the pollen of the fir, it occurred to me as probable that the fir might be common in that part of Ireland where, according to the annals, the shower of a yellow substance resembling sulphur fell; and I learn

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* The names of the places given in the newspapers where the pollen was observed denote, it will probably be admitted, the great extent of surface over which the shower spread. Craigton Cottage and Kilmuir are, I am informed, two miles from Inverness, about eighteen miles from Freeburn, and Kilmuir is about forty-four miles from Kingussie; that is by the mail-road, but no more than thirty-three in a straight line due south.

that it is so. In a letter with which I have been favoured by Mr Wilde, the compiler of the annals, to whom I applied for information, he says,—"I have just seen a person from Doneraile, who informs me, that it is the most thickly wooded part of the county of Cork, and that the timber there is chiefly pine."

2. Some Remarks on the Roman Edition of the Vatican Manuscript. By the Rev. Dr Robert Lee.

Dr Lee commenced with a general account of the existing MSS. of the Greek Scriptures, and particularly of the Uncial MSS. These, though few in number in comparison of the Cursive MSS., are of peculiar value, on account of their greater antiquity and the superior purity of their text. Fac-similes of several of the most important of these interesting documents were exhibited. After making some remarks upon the Alexandrian, the Ephraem, the Beza, and Clermont MSS., Dr Lee remarked that all of these were now, and most of them had long been, available to Biblical scholars by means of the excellent copies which had been issued, the possessors of the documents having afforded every facility and encouragement. The only exception was the Vatican MS., of which he had now to speak, and which had hitherto been withheld from inspection, for reasons which might be guessed but could not be justified. He then proceeded to describe this Codex, chiefly from the accounts of Hug and Tischendorff, concluding, with them, that its age could not be later than the fifth, perhaps not later than the fourth century. The lately issued Roman edition was then considered. The prefaces threw no light upon the delay and obstruction which had occurred—they spoke much, indeed, on the subject, but really said nothing. Dr Lee censured this work on several grounds. 1. Because it wanted Prolegomena, which, in this case, were necessary, and, indeed, indispensable—the more so as the jealousy of the authorities at the Vatican had prevented free access to those who were desirous to examine the Codex. 2. Because the work was gone about in a way which could not but produce manifold mistakes and *maculæ*, which had accordingly been produced. 3. Because the title gave a false description of the Book, which was not "The Old and New Testament according to the Vatican Manuscript," as the title held forth, but the Greek Scriptures from the Vatican MS., and from various other MSS. of different and often uncertain date, of inferior authority, but all far more modern. Not only are the defects of the MS., such as the first forty-seven chapters of Genesis, the Apocalypse, and other smaller defects supplied—excusably, if not commendably—but large masses of matter, which never formed any part of the original document, are arbitrarily inserted—such as the rejected version of Daniel,and the whole four books of the Maccabees; so that the work is rendered enormously voluminous and expensive by the accumulation of matter which has no title to be there, and which is no of value whatever in a critical point of view. But what Dr Lee considered the gravest of the sins with which this expensive edition was chargeable, was the insertion, for dogmatic and ecclesiastical reasons, of those spurious or doubtful passages in the New Testament which are wanting in the Vatican and the other most ancient authorities. Such are Mark xvi. 9–20, Luke xxii. 43, 44, John viii. 1–11, and particularly 1 John v. 7. The editor treated these omissions as if they were defects in his MS.; whereas these passages were insertions—*i. e.*, corruptions introduced into later documents. What made the matter worse was, that in other cases in which the Vatican Codex wanted matter found in the common Greek text, it was omitted by Cardinal A. Mai; such as the Doxology to the Lord's Prayer, Matthew vi. 13, also Matthew xxiii. 14, Acts xxiv. 7, 8, without any reason being assigned, or even any notice taken. This different proceeding in different cases might be considered mere carelessness or accident by those who did not know that the passages arbitrarily introduced had the support of the Latin Vulgate, while those left out wanted that support. For all the three omitted passages before noticed were wanting in that version—the first in all the editions and MSS., the other two in its oldest and best MSS. This was denounced as flagrant partiality. In short (Dr Lee concluded), men who are committed to certain versions and texts, and to certain ecclesiastical systems and interests, have nothing to do to be editing such works as this. They can hardly afford to be quite candid or perfectly honest; and though they were, they can hardly expect to get credit for these virtues. The book which costs nine pounds is, for critical purposes—the only purposes for which it was wanted—not worth nine shillings. Williams and Norgate's reprint of the New Testament part—the only part which is of any importance—is to cost about this moderate sum, and it will possess all the utility and value of the five huge quartos.

3. On the Constitution of Flame. By Mr Swan.

In this communication the author discusses the theory of the constitution of flame advanced by Professor Draper of New York, in his paper "On the Production of Light by Chemical Action," which appeared in the *Philosophical Magazine* for 1848.

Professor Draper refers to experiments which prove that the higher the temperature of an incandescent body, the more refrangible are the rays of light emitted by it. He assumes that the temperature of the outer portions of a flame is greater than that of the interior regions; for outside there is a better supply of oxygen, and hence a more intense combustion is maintained. He thence argues that a flame must consist of a series of layers of different colours following the order of tints in the prismatic spectrum, the red being innermost and the violet outermost. Professor Draper conceives that he has demonstrated by experiment that such a structure actually exists in flame.

Mr Swan, on a careful examination of various flames conducted essentially according to Professor Draper's methods of observation, with the exception of one particular in which that observer's process seemed objectionable, completely failed to verify his results; and on the following grounds believes his views regarding the constitution of flame to be erroneous:—

1*st*, Professor Draper's method of observation, so far as it can be gathered from his somewhat imperfect account of it, involves an error in principle calculated to lead to fallacious results.

2*d*, His theory is founded on the quite gratuitous assumption of a great diversity of temperature between portions of flame so closely contiguous, as to render the existence of such diversity of temperature highly improbable.

3*d*, Even although great diversity of temperature did exist in different portions of a flame, there is no reason to believe that it would give rise to a series of layers of different colours. As the temperature of an incandescent body is raised, rays of continually higher refrangibility are, doubtless, emitted; but these are in every case accompanied by rays of *low* refrangibility. From this it follows that the outer regions of a flame, however high their temperature, will not yield *exclusively* the extreme violet rays of the spectrum, as Professor Draper supposes, but will equally emit the extreme *red* rays. The inference, therefore, regarding the colours of the different regions of a flame which Professor Draper has drawn from their assumed diversity of temperature, is obviously inadmissible.

The following Gentlemen were duly elected Ordinary Fellows of the Society:—

Dr John Brown, F.R.C.P.
Professor Richardson of Durham.

The following Donations to the Library were announced:—

On the Currents of the Ocean. By James D. Dana. 8vo.—*From the Author.*

Review of Marcon's Geology of North America. By James D. Dana. 8vo.—*From the same.*

Francesca da Rimini, her Lament and Vindication. By H. C. Barlow, M.D. 8vo.—*From the Author.*

Physikalske Meddelelser ved Adam Arndtsen. 4to.—*From the Royal University of Norway, Christiania.*

Nyt Magazin for Naturvidenskaberne, ved M. Sars og Th. Kjerulf. 10de Binds, 2 det og, 3 die Hefte. 8vo.—*From the same.*

Om Piperviken og Ruselókbakken. Ved Gilert Sundt. 8vo.—*From the same.*

Ueber das Vorkommen von Quellengebilden in Begleitung des Basaltes der Werra-und Fulda-Gegendender. Von Joh. F. L. Hausmann. 4to.—*From the Author.*

Ueber den Einfluss der Beschaffenheiten du Gesteine auf die Architektur. Von J. F. L. Hausmann. 4to.—*From the Author.*

Oversigt over det Kongelige danske Videnskabernes Selskabs Forhandlinger. Aaret 1857. 8vo.—*From the Society.*

Nachrichten von der Georg-Augusts-Univèrsität und der Königl. Gesellschaft der Wissenschaften zu Göttingen. 1857. 8vo. —*From the Royal Society of Gottingen.*

Acta Academiæ C. L. C. Naturæ Curiosorum. Vol. XXIII., Suppl.; Vol. XXVI., Part 1. 4to.—*From the Academy.*

Kongliga Svenska Vetenskaps-Akademiens Hanlingar. Första Bandet, Andra Häftet, 1856. 4to.—*From the Academy.*

Ofversigt af Kongl. Vetenskaps-Akademiens Forhandlingar. 1857. 8vo.—*From the same.*

Berättelse om Framstegen i Fysik under är 1852. Af E. Edlund. 8vo.—*From the same.*

Kongliga Svenska Fregatten Eugenies Resa Omkring Jorden under befäl af C. A. Virgin. Aren, 1851–1853. Häft 1–5. 4to. —*From the same.*

Journal of the Royal Dublin Society, Nos. 9–11. 8vo.—*From the Society.*

The Assurance Magazine and Journal of the Institute of Actuaries, No. 34.—*From the Institute.*

Meteorologische Beobachtungen aufgezeichnet an der Konigl. Sternwarte bei Munchen in den Jahren, 1825–37. 8vo.—*From the Royal Observatory of Munich.*

Annalen der Königl. Sternwarte bei Munchen. 10 Band. 8vo.—*From the same.*

Astronomische Beobachtungen auf der Königl. Universitäts-Sternwarte zu Konigsberg. 33 Abtheilung. Folio.—*From the University.*

Observations on British Zoophytes, Descriptions of New Protozoa and of two Tubicolar Animals. By Dr T. Strethill Wright. 7 Pamphlets. 8vo.—*From the Author.*

Monday, 7th February 1859.

PROFESSOR KELLAND, Vice-President, in the Chair.

The following Communications were read:—

1. Biographical Memoir of the late Dr D. Skene of Aberdeen. By Alex. Thomson, Esq. of Banchory.

This memoir commences by stating that it seemed desirable to arrange and preserve what memorials could still be found of one who had done very much to promote the study of natural science in Scotland, but whose memory had well-nigh perished.

Dr Skene's father and grandfather were both eminent physicians in Aberdeen, where he was born, on 13th August 1731.

His early education was conducted in Aberdeen. He spent the winter of 1751–2 in Edinburgh, attending various medical classes; and in the autumn of 1752 proceeded to London, where he studied under Hunter and Smellie, besides attending several of the hospitals.

In January 1753 he went for a few months to Paris, in order still further to advance his professional studies. Extracts from letters to his family were read, giving vivid and interesting descriptions of men and manners, and especially of his various teachers; of the insolence of the Parisian Perruquiers, and how they obstructed the other students; and of the cost and worthlessness of the Rheims degrees of M.D., the possession of which was concealed by the owner like the commission of a crime.

Dr Skene returned to Aberdeen in the summer of 1753, and on 8th September of that year received the degree of M.D. from King's College and University; and settled permanently as assistant to his father in Aberdeen.

From 1753 to 1765, he carried on his researches in Natural History without aid, except from such books as then existed.* No trace of scientific correspondence has been discovered, until his first letter to Mr Ellis, the well-known writer on corallines, in 1765. From that time to his death he kept up a close correspondence and interchange of specimens with Mr Ellis—discussing particularly, at great length, the whole question of the nature of zoophytes, sponges, and corallines; the correspondence throwing much light on the state of natural science at the time.

In the same year Skene commenced a correspondence with Linnæus; and the original letters of Linnæus were laid on the table, with the scroll-letters of Skene. Skene wrote good Latin, and frankly controverted the opinions of the illustrious Swede on the nature of zoophytes,—maintaining them to be animals,—the constructors of their dwellings, and in opposition to the theory that the dwellings constructed the animals.

During their correspondence, the twelfth edition of the *Systema Naturæ* was in the press, and Skene is repeatedly given as authority by Linnæus. It is evident that he was much pleased with his only Scottish correspondent—"Ubi præter te nullum curiosum novi."

In 1769, Skene began to correspond with Pennant; and a regular correspondence was maintained during the rest of his life. He is frequently quoted in the *Fauna*, prefixed to Lightfoot's *Flora Scotica*.

Several proposals were made to make Skene a professor in Aberdeen, and Glasgow, and Edinburgh, but he showed no great desire

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* The only instructions he had on any branch were during a few weeks' attendance on Dr Alston's Lectures, in the Botanic Garden, Edinburgh.

to quit his established position in his native town, in many respects well suited to his tastes.

One correspondence, which was read, laid open a singular negotiation for the *sale* of an Edinburgh Professorship, the most remarkable feature of which was, that none of the parties concerned seem to have had the slightest idea that they were engaged in a most improper transaction.

Among his school correspondents whose letters have been preserved, are to be found Dr Hope, Dr Reid, whose letters to Skene were printed by Sir William Hamilton in his Life of Reid, Mr Walker of Moffat, Lord Kaimes, &c. &c.

Skene was an active member of the Aberdeen Philosophical Society, where he read many papers on a great variety of subjects; and he was also a member of a Musical Society. In 1769 he was admitted a member of the Edinburgh Philosophical Society, but did not contribute any papers.

He died in December 1770, at the early age of 38. He left behind him a very considerable quantity of MSS., embracing, in one form or other, most branches of human knowledge; and the catalogue of his library proves him to have been a very accomplished general scholar.

Several volumes of these papers were laid on the table; the most important of which were three volumes of botanical, zoological, and entomological descriptions; and one containing a "Discourse on the Study of Natural History," on which he had bestowed much pains, as several copies have been found among his papers, in various stages of progress.

Few of his papers are dated, so that it is not easy from them to trace his progress; but much of his knowledge must have been acquired before the commencement of his scientific correspondence, which extends only over the last three or four years of his life. His letters show that he possessed one characteristic of a true naturalist, viz., his willingness to communicate to others whatever facts he had ascertained, and whatever specimens he could collect. Though his early death prevented his publishing, it is very clear that he contemplated the preparation of a complete Fauna and Flora of his own neighbourhood, if not of the whole of Scotland; and it is impossible to say how much natural science in Scotland may have been indebted to him, from the impulse he communicated to all with whom he came in contact.

The memoir concluded by stating, that though the subject could not be very interesting to those devoted to the active study of natural science at the present day, it had its value to those who took pleasure in studying the progress of human knowledge.

2. On a new Arrow-Poison from China. By Dr Christison.

In a newspaper printed at Shanghae, in the spring of 1857, a wonderful account was given of a poison, which was said to be employed in the interior of China for destroying the largest animals. Instant death was said to be produced, when an animal was struck in the trunk of the body with an arrow poisoned with it. Such was its potency, according to the opinion of the Chinese, that a scheme was said to have been set on foot for destroying the British army during the late war, by bringing down to Canton the natives who were in the practice of using it. But the scheme was frustrated by peace being unfortunately proclaimed too soon.

The poison, and apparently the plant also, are known by the Chinese name of *Wu-Tsau*, or Tiger-poison. The author received very lately from Dr Macgowan, an American physician residing at Shanghae, a specimen of the poison, and of the root of the plant from which it is prepared. The root presents all the characters of an *Aconitum* on a very small scale. This corresponds with the conclusion to be drawn from the characters of a few leaves which were also sent, and which scarcely differ from those of *Aconitum ferox.* A farther proof is, that the root produces in an intense degree the very singular combination of numbness and tingling, which is occasioned by chewing the root of any of the active aconites known in Europe, such as *A. Napellus*, *ferox*, *sinense*, or *uncinatum.* The poison itself, contained in a little porcelain bottle, is obviously a very well prepared extract; and, if not entirely composed of the extract of the wu-tsau root, at all events must contain it largely, for a very minute quantity produces the most intense tingling and numbness of the tongue and lips after it is chewed.

There can be no doubt, therefore, that the wu-tsau poison must be extremely energetic. But the author objected to the admission that either this or any other arrow-poison can produce instant death, as is often stated by travellers. Every poison, however energetic, must be absorbed into the blood before it can act. Even from a wound, absorption cannot take place suddenly. Some time is required before enough can enter the blood. When death takes place instantly, the cause must be the mechanical violence inflicted by the arrow. The author exhibited various poison-arrows used in different parts of the world, which were adequate to occasion most deadly wounds if they struck the trunk of the body over an important organ; and he also showed that even the little slender wooden poison-darts, used in some parts of the world for destroying birds and small animals, by being shot from a blowing-tube, may be easily projected with a force amply sufficient to kill a small bird or animal by the violence inflicted, apart from the more tardy deleterious influence exerted by the poison.

3. On the Connection between Temperature and Electrical Resistance in the simple Metals. By Balfour Stewart, Esq.

About a fortnight since I mentioned to Professor Forbes that the resistances of the simple metals to the passage of electricity seemed to be very nearly in proportion to their absolute temperature, this relation being especially manifest for those values of the resistances determined by M. Arndtsen.

Professor Forbes informed me that this coincidence had already been observed by Professor Clausius, and that an abstract of his paper was given in the *Philosophical Magazine* for November last. On referring to Professor Clausius's original paper, it would seem that the coincidence had suggested itself to him as a remarkable similarity occurring between the rate of increase (due to temperature) of the electrical resistance of those metals, and that of the volume of a gas under constant pressure. It would seem that the fact was unconnected in his mind with any theoretical considerations.

As, however, I was led to look for and remark the coincidence by theoretical considerations, perhaps this Society will permit me to lay before them a short statement of my views.

The passage of electricity along a wire is generally viewed in the following light:—The free electricity of one particle decomposes the electricity of the particle next it; the two electricities then combine by sparking across the interval; and the same thing is renewed over and over again with extreme rapidity. Now, whether electricity be viewed as a substance or a motion, we may suppose that a polarized state of particles is alternately produced and destroyed with great rapidity while an electrical current passes along a conducting wire.

And by a polarized state of particles we would mean a peculiar disposition with respect to the direction in which the electricity is travelling, of the *matter*, or it may be *motion*, of the particles of the substance.

Again, an idea very generally entertained with regard to heat is, that it consists in a vortical or rotatory motion of the particles of a substance.

Now, with only very general ideas regarding the mode of electrical conduction and the nature of electricity, we may suppose that the polarization which conduction demands will be resisted in proportion to the rotatory energy of the particle; just as a rapidly rotating top or cylinder would resist any attempt to change its plane of motion.

The resistance of a particle to electrical polarization would, therefore, be in proportion to its rotatory *vis viva*—viz., its absolute temperature. This only holds with regard to simple bodies; in compound bodies the passage of electricity may be supposed to be a more complicated phenomenon.

31*st January* 1859.

The following Gentleman was duly elected an Ordinary Fellow of the Society :—

Rev. JOHN DUNS, Torphichen.

The following Donations to the Library were announced :—

Bulletin la Société Vaudoise des Sciences Naturelles. Tome VI. Bulletin, No. 43. 8vo.—*From the Society.*

Catalogue de la Bibliotheque de la Société Vaudoise. 8vo.—*From the Society.*

Almanaque Nautico para 1860, calculado de ōrden de S. M. en el Observatorio de Marina de la Ciudad de San Fernando. 8vo. —*From the Observatory.*

Mémoire sur la Relation des Sources Thermales de Plombières, avec les Filons Metalliferes, et sur la formation contemporaire des Zéolithes. Par M. Daubrée. 8vo.—*From the Author.*

Recherches Experimentales sur le Striage des Roches du au Phénomène Erratique. Par M. Daubrée. 8vo.—*From the Author.*

Observations sur le Métamorphisme. Par M. Daubrée. 8vo.—*From the Author.*

Journal of the Proceedings of the Linnæan Society. Vol. III. No. 11. 8vo.—*From the Society.*

Transactions of the Linnæan Society. Vol. XXII. Part 3. 4to.—*From the Society.*

Transactions of the Historic Society of Lancashire and Cheshire. Vol. X. 8vo.—*From the Society.*

Transactions of the Botanical Society of Edinburgh. Vol. VI. Part 1. 8vo.—*From the Society.*

Atlantis, a Register of Literature and Science, conducted by the Members of the Catholic University of Ireland. No. III. 8vo.—*From the Editors.*

Siluria. By Sir R. I. Murchison. 3d Edition. 8vo.—*From the Author.*

The Canadian Journal of Industry, Science, and Art. Nov. 1858. 8vo.—*From the Canadian Institute.*

The Statistics of Marriage in England. By S. M. Drach. 8vo.—*From the Author.*

Horæ Subsecivæ. Locke and Sydenham, with other occasional papers by John Brown, M.D. 8vo.—*From the Author.*

Proceedings of the Berwickshire Naturalists' Club. Vol. IV., No. 2. 8vo.—*From the Club.*

Monday, 21*st February* 1859.

PROFESSOR CHRISTISON, Vice-President, in the Chair.

The following Communications were read:—

1. Remarks on the Behaviour of Mercury as an Electrode. By T. Strethill Wright, M.D., &c. Communicated by William Swan, Esq. The experiments were shown.

In this paper the author described numerous experiments, serving to show the modification which occurred in the capillary attraction between mercury on the one hand, and various saline and acid fluids forming parts of active voltaic circles on the other. He also described and showed to the Society the undulatory motions which he had observed in mercury, when forming the cathode of a constant voltaic current in solutions of chloride of sodium, containing small quantities of sulphuric acid.

2. On the Natural History of the Herring. By J. M. Mitchell, Esq. Communicated by Dr Allman.

Before entering on the details of the natural history of the herring, the author points out the great value of the herring-fishery to the maritime nations of Europe; and quotes various scientific authorities to show, that the herring is superior in economical importance to every other fish. Thus Cuvier, in his work on fishes, edited by Professor Valenciennes, says,—" Les grands politiques, les plus habiles economistes ont vu dans la pêche du hareng la plus importante des expeditions maritimes."

Such views have led the British, Dutch, Swedish, and Norwegian governments, to inquire at present into the natural history, and to legislate regarding the fishery of the herring. The author has described the principal steps taken by these nations, and has given important statistical details of the British herring fishery, showing, that fish, to the value of upwards of a million sterling are annually taken on our coasts.

The high value of the fishery, not only in promoting the welfare of a large portion of our population, but in producing a strong, hardy, and industrious race of fishermen, most valuable to such a maritime nation as Britain, is next referred to.

The author then points out various errors regarding the herring which have been committed in works of high authority, such as Cuvier's work on fishes, already referred to, M'Culloch's Dictionary of Commerce, and the last edition of the Encyclopædia Britannica. He conceives that he has solved the doubtful questions, regarding the natural history of the herring,—an object of the greatest importance, when we consider the high economical value of the fishery. He also points out several new and important facts regarding the appearance of the fish on our coasts. Among others, that the herring swims nearest the surface in dark and mild weather ; and nearer the bottom when the weather is bright and cold.

He next enters on the details of the natural history of the herring, describing its characteristics and its distinctive difference from other fishes of its class. The important question of its food, is elaborately examined; and it is shown, as stated to the author by Agassiz, that the herring does not confine itself to one species of food, namely that the food usually consists of minute crustacea; but during the spawning season it feeds on sand-eels, the fry of various fishes, and even its own spawn.

The author has ascertained a new and important fact from personal observation, regarding the cohesion of the spawn, and the power of adhering strongly to substances on which it may be placed, which only takes place on the fecundation of the roe by the milt.

Many writers reiterate the opinion, that the herring is a native of the distant northern seas. This the author shows to be an error, proving that the fish is a permanent inhabitant of our coasts.

He, for the first time, gives a complete description of the visits of the herring, or its geographical and chronological distribution over the surface of the globe, so far as is known ; and his work is the first and only one which exhausts the difficult questions which have hitherto arisen regarding the most valuable and important fish, which the bounty of Providence sends to supply food for the human race.

Monday, 7th March 1859.

PROFESSOR KELLAND, Vice-President, in the Chair.

The following Communications were read:—

1. Some Inquiries concerning Terrestrial Temperature. By Professor J. D. Forbes.

In this paper the writer starts by assuming Dove's Temperatures for the mean of every 10th parallel of latitude, from 75° N. to 40° S., to be correct. His object is to inquire how far the influence of the proportion of land and water in modifying the annual temperature of a given parallel is susceptible of being reduced to a formula.

The amount of land and water in different latitudes is first tabulated. It is then shown, from an examination of the ordinary isothermal curves, and also from Dove's charts of the "Thermic Anomaly," that the influence of land is to exalt the temperature of lower latitudes, and to depress that of higher latitudes. About the latitude of 42 °or 43° this influence is *nil;* and the temperature of that parallel is independent of the proportions of land and water. For convenience of calculation, however, the latitude of 45° is assumed as the one free from this anomaly.

The writer shows that the decrement of temperature along an oceanic meridian (that of Greenwich, for example) proceeds nearly as the simple cosine of the latitude (which is Sir D. Brewster's formula); while along a continental meridian (one passing through Siberia) it is more nearly as the square of the cosine (the law of Mayer.)

Hence it is argued that the temperature of any parallel may probably be represented by a formula containing (1) a constant; (2) a term varying with a power of the cosine not differing much from unity; (3) a term for the effect of land, containing as a factor the proportion of land on the parallel, and also the factor cos. $\overline{2 \text{ lat.}}$, which renders it additive below 45°, and subtractive afterwards.

Considering, first, the northern hemisphere alone, the constants are introduced into such a formula by a comparison of the observed temperatures of latitudes 0°, 30°, 50°, and 70°, with the following result:—

$$T_{\lambda} = 12^{\circ}\cdot 5 + 59^{\circ}\cdot 2 \cos. \tfrac{5}{4}\lambda + 38^{\circ}\cdot 1\, L' \cos. \overline{2\lambda}$$

where T_{λ} is the temperature of latitude λ on Fahrenheit's scale, and L' the effective proportion of land in the circumference of that parallel.

The extension of the formula to the southern hemisphere is shown to give satisfactory results, although all merely *empirical* formulæ for the northern hemisphere altogether fail in this case.

Some other and independent confirmations of the formula are then adduced.

Supposing the globe to be entirely composed of land, or entirely of water, the temperature of any parallel may be deduced from the formula. In the case of a globe all land, the Equatorial temperature would be about 110°, and the Polar temperature about −26°; whereas, on an aqueous sphere, the former would be about 72°, and the latter +12°.

2. On the Spermogones and Pycnides of Lichens. By W. Lauder Lindsay, M.D., F.L.S. Communicated by Prof. J. H. Balfour.

The researches contained in the author's memoir, of which the following is a brief abstract, extended over a period of several years, and are based on careful microscopic examination of several thousand specimens of lichens from every part of the known world. The author examined the lichens of the Hookerian Herbarium at Kew, which contains an unrivalled series of specimens collected by the various surveying and exploring expeditions of the British Government, as well as by all the more distinguished modern British travellers. This collection is further valuable, from containing authentic specimens collected and named by Borrer, Turner, Hooker, Brodie, Carmichael, Babington, and other distinguished British lichenologists, as well as by Acharius, Schærer, Swartz, and other continental authors. Access was also had to the Menziesian Herbarium in the University of Edinburgh, the Herbaria of the said University, of the Botanical Society of Edinburgh, of the Museum of Irish

Industry, Dublin, and of Dr Mackay of Dublin, which last contains authentic specimens of the lichens described by Dr Taylor in the "Flora Hibernica." The fasciculi of dried specimens published by Schærer, Hepp, Leighton, and others, as well as large numbers of specimens gathered in, and sent from, various parts of England, Wales, Scotland, and Ireland, were also examined. Besides the examination of dried specimens in herbaria, the author studied lichens extensively in their native habitats on the mountains of Scotland and Norway, and elsewhere.

With the exception of two short memoirs,* already published by the author, the researches in question are the first that have been made on the subject under review in this country. The memoir is essentially organographic, and gives full details of the characters of the spermogones and pycnides of the higher lichens,—that section, namely, which comprises fruticulose, filamentous, and foliaceous species. The genera, whose spermogones and pycnides are described, are:—

1. *Usnea*, Hoffm.
2. *Neuropogon*, Nees and Flot.
3. *Chlorea*, Nyl.
4. *Alectoria*, Ach.
5. *Evernia*, Ach.
6. *Dufourea*, Ach.
7. *Dactylina*, Ach.
8. *Ramalina*, Ach.
9. *Roccella*, Bauh.
10. *Thamnolia*, Ach.
11. *Sphærophoron*, Pers.
12. *Acroscyphus*, Lév.
13. *Stereocaulon*, Schreb.
14. *Bæomyces*, Pers.
15. *Cladonia*, Hoffm.
16. *Umbilicaria*, Hoffm.
17. *Cetraria*, Ach.
18. *Platysma*, Hoffm.
19. *Nephromium*, Nyl.
20. *Peltigera*, Hoffm.
21. *Solorina*, Ach.
22. *Sticta*, Ach.
23. *Ricasolia*, DN.
24. *Parmelia*, Ach.
25. *Physcia*, Fr.
26. *Pyxine*, Fr.
27. *Psoroma*, Fr.
28. *Pannaria*, Del.
29. *Coccocarpia*, Pers.
30. *Amphiloma*, Fr.
31. *Squamaria*, DC.
32. *Placodium*, DC.
33. *Ephebe*, Fr.
34. *Lichina*, Ag.
35. *Synalissa*, DR.
36. *Omphalaria*, DR. and Mont.
37. *Collema*, Ach.
38. *Leptogium*, Fr.
39. *Obryzum*, Wallr.†

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* 1. "Monograph of the Genus *Abrothallus*." Quarterly Journal of Microscopical Science, Jan. 1857. Transactions of British Association for 1856. Botanische Zeitung, Dec. 25, 1857.

2. "On the Structure of *Lecidea lugubris*." Quart. Journ. of Microsc. Science, July 1857.

† The nomenclature and arrangement followed here and in the Memoir is that of Dr Nylander of Paris, as given in his "Synopsis methodica Lichenum omnium hucusque cognitorum." Paris, 1858. Pp. 65.

The crustaceous section of the lichen family has been examined by the author in a similar manner; but the description of the pycnides and spermogones of the lower lichens is reserved for a separate memoir. Neither does he profess to enter upon the *questio vexata* of the physiology of reproduction in lichens generally. To this subject also he proposes devoting a special memoir. The memoir contains, *inter alia*, descriptions of the spermogones, or pycnides, of many species, in which they either have not hitherto been found, or in which they are very rare and difficult of discovery. Such are the spermogones of *Usnea barbata*, *Thamnolia vermicularis*, *Neuropogon melaxanthus*, *Alectoria jubata* and *A. Taylori*, *Evernia furfuracea*, *Lecanora tartarea*, &c. The letter-press of the memoir is accompanied by 16 quarto plates of coloured drawings —amounting to several hundreds—and by specimens of lichens, bearing spermogones or pycnides, amounting to about 140.

Among the more interesting or important general facts brought out by the memoir, may be enumerated the following:—

1. In addition to the sporiferous organs,—so long familiar to botanists,—called *Apothecia*, lichens possess more or less microscopically minute organs, called *Spermogones*. The *latter* organs the author has found alike in species from arctic and antarctic, temperate and equatorial, regions.

2. The spermogones of lichens may concisely be described as follows:—In *form* they are usually more or less spherical or oval, appearing on the surface of the thallus as punctiform or papillæform, wart-like or barrel-shaped, bodies. In *colour* they are usually blackish, brownish, or of divers colours. In *site* they are usually scattered over particular portions of the thallus—seldom generally over its whole surface; they are usually more or less immersed in the tissues of the thallus, sometimes they are sessile on its surface, or on the apices of its ramifications, when it is erect and fruticulose. In *size* they are seldom sufficiently large to be visible to the naked eye, and are frequently so minute that they can, with difficulty, be recognised even with the aid of a good lens. In the latter case, especially, it is advisable or necessary to moisten the thallus in order to render them prominent from the contrast of colour or surface. They consist of a capsule, enclosing a cavity, that opens to the surface by a minute pore or ostiole, which is generally of a darker colour than the said capsule. From the inner wall or surface of the

capsule project, convergently into the cavity, a series of filaments, closely aggregated, called *Sterigmata*. These are either simple, formed of a single elongated cell,—or compound, made up of a series of cells, varying in size and form, superimposed the one upon the other. They produce from their apices, when simple,—from apices and sides, when compound or articulated,—a succession of very minute, solid, homogeneous corpuscles, called *Spermatia*. Just as the importance of the apothecia resides in the spores, so the importance of the spermogones resides in the spermatia. These corpuscles are destitute of any essentially vital motions, though they frequently, from their great tenuity, exhibit Brownian or molecular movements. Nor are they provided with any such appendages as cilia.

3. Spermogones usually occur on the same plant or specimen which bears apothecia: sometimes, however, only on barren plants or specimens. Hence, in regard to apothecia and spermogones, lichens have been described by continental authors as monœcious and diœcious. Again, spermogones occur in some species which never bear apothecia, as in *Thamnolia vermicularis*.

4. Spermogoniferous states of many species are what were regarded by the older lichenologists as separate varieties, species, or even genera, *e. g.*, vars. *encausta* and *vittata* of *Parmelia physodes*, and var. *denticulata* of *Platysma nivalis*. The discovery, therefore, of spermogones and pycnides simplifies lichenology by abolishing certain genera, species, and varieties, and materially reducing the number of names, *e. g.* the old genera *Cliostomum*, *Thrombium*, and *Pyrenothea*, being found to consist wholly of spermogoniferous states of more familiar lichens, have been abolished.

5. To a certain extent, or with trifling exceptions, just as certain families or genera of lichens are characterised by apothecia and spores of a particular kind, so they are also characterised frequently by spermogones, sterigmata, and spermatia of a particular kind. Thus *Usnea* and *Ramalina* have wart-like spermogones of the same colour with the thallus, and inconspicuous in consequence thereof. The spermogones of *Cladonia* are barrel-shaped, deep brown, and easily visible. Those of *Parmelia* are mostly punctiform, immersed, black or brown, very minute and crowded; those of *Physcia* are mostly papillæform; and those of *Collema* and *Leptogium* discoid, and of a pale brown or yellow colour. In *Sticta*, *Ricasolia*,

Umbilicaria, *Collema*, *Leptogium*, *Thamnolia*, *Coccocarpia*, and *Placodium*, the sterigmata are articulated, consisting of numerous, short, broadish, frequently thick-walled, cells. They are also articulated or compound,—but the component cellules are few, longish, and delicate,—in *Usnea*, *Neuropogon*, *Parmelia*, *Evernia*, and *Platysma*. They are simple and filiform in *Ramalina*, *Cladonia*, *Ephebe*, and *Lichina*. The spermatia of *Cladonia* and *Roccella* are curved or sickle-shaped. Those of *Squamaria* are very long, slender, and twisted or curved. Those of *Collema*, *Leptogium*, and *Umbilicaria* are short, straight rods; while those of *Ramalina*, *Ephebe*, and *Lichina*, are oblong or oval-oblong.

6. The spermogones sometimes of themselves yield important characters for classification. For instance, the spermogones, sterigmata, and spermatia of *Thamnolia vermicularis* are sufficient of themselves to separate this puzzling lichen from the genus *Cladonia*, in which it has hitherto been almost uniformly placed.

7. Spermogones frequently outwardly resemble, and are therefore apt to be confounded with—

a. Nascent apothecia, as in some *Ricasolias;*
b. Pycnides, described below;
c. Minute *Verrucarias;* or
d. Minute parasitic fungi, chiefly of the genus *Sphæria*.

For instance, the author frequently receives from correspondents as *new Verrucarias* what prove to be merely spermogoniferous states of other lichens. From all the bodies above named, spermogones may at once be distinguished by microscopic examination, and by this alone.

8. The spermogones of lichens are now generally regarded as male organs of reproduction—the spermatia being supposed to be analogous in function to the antherozoids or spermatozoids of other cryptogams, and to be endowed with a fecundating or fertilizing influence on the spores. But it is necessary to state distinctly that this is a mere hypothesis, for direct or distinct proof is still wanting. The following circumstances, however, give great support to this hypothesis, and ought, at all events, to be borne constantly in mind in all speculations on the functions of the spermogones and spermatia:—

a. Intimate relation between the spermogones and apothecia in regard to *site*—the former being generally seated in close proximity to the latter. As illustrations of this intimate relationship, it may be stated that spermogones sometimes occur—

1. In the hypothecial tissue of the apothecium itself, as in *Celidium fusco-purpureum*, Tul. [Mém., Pl. 14., f. 12.]
2. On the apothecium itself, as in *Lichina pygmæa* and *confinis*, and sometimes in *Cladonia rangiferina*.
3. On the exciple of the apothecium, as in *Urceolaria scruposa* and *Parmelia conspersa*.

b. Relative period of development,—the spermogones normally preceding the apothecia. Spermogones should therefore be looked for in specimens bearing no apothecia or young apothecia; when the apothecia are mature, we should expect to find the spermogones old, and perhaps degenerate.

c. Relative abundance of spermatia and spores,—the former being infinitely more numerous than the latter.

d. Relative size of spermatia and spores,—the former being infinitely the smaller.

e. Essential difference in structure between spermatia and spores, the former being solid, simple, or homogeneous, without septa; the latter vesicular, frequently compound or septate, with heterogeneous contents.

f. Essential difference in form, the spermatia being usually elongated and of extreme tenuity, the spores being generally oval or spherical.

g. Greater constancy of size in spermatia than in spores, which are frequently very variable in this respect. Some spermatia are much larger when attached to their sterigmata than when free—as in some *Parmelias;* but this is only an apparent anomaly, for it would appear that they normally split into two on being shed from their sterigmata.

h. Absence of all germinative faculty,—so far as yet known.

i. Similarity in structure between the capsule or envelope of the spermogone and the exciple of the apothecium,—the cellular tissue of which they are composed being generally the same.

k. Constancy of occurrence of spermogones in all lichens, and from every part of the world yet visited by man.

9. Many lichens possess, in addition to apothecia and spermogones, minute organs, outwardly resembling spermogones, called

Pycnides. They may be described in general terms as papillæform or wart-like bodies, generally black,—sometimes brown,—usually very minute,—generally partially immersed in the thallus, on the surface of which they are scattered,—occupying a site similar to that of the spermogones. Indeed they differ essentially from spermogones only in containing corpuscles, called *Stylospores*, which are spore-like bodies,—sometimes septate,—usually oval or pyriform in shape,—but varying greatly both in form and size, with oily, distinct contents, always borne on the apices only of simple or unicellular, strongish sterigmata.

10. As the essential difference between spermogones and pycnides lies in the characters of the contained corpuscles, and as their characters are of great importance, as bearing on the physiological functions of the said corpuscles, the comparison or contrast undernoted is made:—

Spermatia. [representing Spermogones.]	*Stylospores.* [representing Pycnides.]
1. Structure solid, homogeneous.	1. Hollow: contents heterogeneous—in part, at least, oily.
2. Always colourless.	2. Sometimes pale yellow.
3. Of extreme tenuity: generally linear—of equal thickness throughout—straight or curved—never spherical.	3. Vesicular: usually oval or pyriform.
4. Of uniform size and shape.	4. Varying more or less in size and shape.
5. Exist in myriads.	5. Greatly less abundant.
6. Absence of germinative power.	6. Presence of germinative power.
7. No oil globules intermixed: embedded in a mucilage.	7. Oil globules generally intermixed.
8. Borne on the apices and sides of the sterigmata—on the apices when they are simple, on the apices and sides when articulated.	8. Borne on the apices only of sterigmata, which are always simple and stoutish.

11. There is much more dubiety and difficulty regarding the nature of the pycnides and the functions of the stylospores than regarding the nature and functions of the spermogones and spermatia. Two hypotheses have been advanced regarding the pycnides and stylospores, viz.—

a. That they are substitutes for the spermogones and spermatia,—or in other words, a different form or type thereof. What lends probability to this view, is the perfect resemblance to spermogones in outward appearance, site, &c. of such pycnides as those of *Peltigera*, in which the contained corpuscles are the only reason for regarding the conceptacles as pycnides rather than spermogones. But in certian lichens pycnides co-exist with spermogones of the ordinary character.

b. That they are sporoid in function as well as form and general aspect. The strong argument in favour of this view is their germinative faculty. According to this view, pycnides may be regarded as secondary apothecia, or female organs, —and stylospores as secondary or supplementary spores. It has been noticed that, in certain cases, there is a general resemblance in form between the stylospores and the spores of the same species; but this, if not exceptional, is still far from being the general rule.

12. Pycnides are much more common among the lower, or crustaceous, lichens, than among the higher or fruticulose, filamentous, and foliaceous ones; while, on the other hand, the spermogones are most abundant and distinct in the latter. Pycnides would appear to be a connecting link between the lichens and the fungi, and we find them most frequent, perhaps, in species most nearly allied to the fungi.

13. Pycnides may occur in plants or specimens bearing apothecia, but not spermogones; or they may occur alone, both apothecia and spermogones being absent; or pycnides and spermogones, one or both, may occur in species seldom or never bearing apothecia, as in some species of *Strigula*.

14. Pycnides, from their outward resemblances, are apt to be confounded with, or mistaken for,—

a. Spermogones.

b. Minute *Verrucarias*.

c. Minute parasitic fungi, for which, indeed, they have hitherto been almost universally mistaken. Pycnides resemble the fructifications of fungi, called by the older mycologists, *Diplodia*, *Phoma*, *Septoria*, *Cytispora*, *Sclerotium*, *Mesalmia*, *Phyllosticta*, and *Polystigma*.

15. A few lichens,—especially crustaceous ones,—possess several forms of spermogones, or of pycnides, or of both,—though such a phenomenon is comparatively rare. This is just what occurs in such fungi as *Erysiphe*, which has *five* several forms of reproductive

organs. The simultaneous occurrence of spermogones and pycnides also characterises certain fungi, *e.g.*, *Sphæria epicymatia*, Wallr. Indeed, the presence of multiform reproductive organs in lichens, renders more indefinite and unsatisfactory the line of definition between them and the fungi; or in other words, renders more clear and intimate the alliance between these two great cryptogamic families.

16. By the discovery in Germany in 1850, and the subsequent description by various French and German authors, of the spermogones and pycnides of lichens, this family of plants has been placed on, at least, as good a footing, in respect of their anatomy and physiology, as other cryptogamic families, which have hitherto been more carefully and successfully studied.

The following Donations to the Library were announced:—

Anniversary Address to the Geological Society of London. By Major-General Portlock, R.E. 8vo.—*From the Author.*

The Quarterly Journal of the Geological Society. February 1859. 8vo.—*From the Society.*

The American Journal of Science and Arts. January 1859. 8vo. *From the Editors.*

Proceedings of the Royal Geographical Society of London. Vol. III. No. I. 8vo.—*From the Society.*

Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland. No. 64 (March 1859). 8vo. —*From the Society.*

Quarterly Journal of the Chemical Society. January 1859. 8vo. —*From the Society.*

Journal of the Statistical Society of London. Vol. XXII. Part. 1. 8vo.—*From the Society.*

A Catalogue of the Graduates in the Faculties of Arts, Divinity, and Law, of the University of Edinburgh since its Foundation. 8vo.—*From the University.*

Comets: their Constitution and Phases. By Christopher Kemplay. 8vo.—*From the Leeds Philosophical and Literary Society.*

Report on the Teneriffe Astronomical Experiment of 1856. Addressed to the Lords Commissioners of the Admiralty. By Professor C. P. Smyth. 4to. *From the Author.*

Report of the Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire. 1857–8. 8vo.—*From the Society.*

China and its Trade. By John Crawfurd, F.R.S. 8vo.—*From the Philosophical and Literary Society of Leeds.*

Sensorial Vision. By Sir J. F. W. Herschel, Bart. 8vo.—*From the same.*

Annual Report of the Leeds Philosophical and Literary Society for 1857–8. 8vo.—*From the Society.*

On the Structure of Lecidia lugubris. By W. Lauder Lindsay, M.D. 8vo.—*From the Author.*

Atti dell' imp. Reg. Istituto Veneto de Scienze, Lettere ed Arti. Dal Novembre 1858 all' Ottobre 1859. Tomo IV. Dispensa Terza. 8vo.—*From the Institute.*

Transactions of the Botanical Society of Edinburgh. Vol. I. Part 3. Vols. II., III., IV., and V. Proceedings for 1856. Sixth, Seventh, and Eighth Annual Reports and Proceedings for 1841–44. 8vo.—*From the Society.*

Donation to the Museum—

Geological Specimens from the Peak of Teneriffe.—*By Professor C. Piazzi Smyth.*

Monday, 21st March 1859.

PROFESSOR KELLAND, Vice-President, in the Chair.

The following Communications were read:—

1. On some First Principles of a Mental Science, deduced from Correlations of the Primary Laws of Matter and Mind. By Dr Laycock.

The author commences his communication by showing the need that has arisen for a scientific exposition of the laws of thought in relation to the laws of life and organization. In all the practical business of society, as well as of the physician, the phenomena of life and mind are inseparably associated; and consequently without such scientific exposition anything like a scientific application of mental philosophy to medicine and the sciences of human nature, included under sociology, is impossible. But physiology is itself a derivative science, inasmuch as vital processes are primarily dependent upon certain molecular forces of matter, known as light, heat, chemical affinity, &c. Consequently, if philosophy cannot be separated from physiology or the science of vital function, neither can physiology be separated from physics. Philosophy, therefore, ought to include in one harmonious and comprehensive body of doctrine all the fundamental principles of the natural sciences. It would to this end take cognisance of three great departments of human knowledge—the physical, the vital or biological, and the metaphysical.

The author next shows that as science has already developed in each of these departments a number of general laws which only await higher generalizations to bring them all under laws still more general, and thus secure that unity of the sciences to which they all tend, it is the proper business of philosophy to supply those higher generalizations. These, the author argues, must be derived from the common sense and experience of mankind; for that experience consists in a knowledge of the laws of nature,—not formularized, it is allowed, in express propositions,—but acted upon by man in all his relations. The experience of mankind is *expressed*, however, in at least three different, yet closely related modes—namely, in his language, in the laws which regulate his conduct as a social being, and in his conduct as an individual. If man's experience of the great uniformities of nature, as expressed in these three modes, can be compared with the results of scientific research and formularized into general propositions, these propositions will express fundamental empirical laws fit to be received amongst the highest generalizations of philosophy, considered as a practical knowledge of the general laws of nature. After having shown by illustrations the application of this method of deducing general empirical laws, the author proceeds to examine the generalizations or fundamental ideas implied in the words *law*, *force*, *mind*.

The term *law*, as commonly used, denotes the written or spoken words in or by which is expressed the will of any person or persons, having the power to compel others to adapt their conduct to the will so expressed. Conduct so compelled would be a uniform succession of events occurring according to law. In science, whenever a uniform succession of events or of phenomena in nature is observed to take place, the expression in words or signs of that uniformity is termed a law. Thus it is a law of nature that air has weight, that all men die, and the like. But, as the order of succession is logically a fixed and necessary order, so the law which represents or expresses the order is logically a necessary law. In this attribute of fixedness the mind recognises a resemblance between the order and the law which expresses it, so that as to the quality of necessity and fixedness, the law and the order are convertible things, and the law stands for the order.

Force is a word arising out of man's experience of this necessary order of events. He finds the fixed order to be an inevitable order, and this idea of inevitableness implies logically an irresistible force or power which compels to or maintains the order. Hence, correlative with order and law there is a conception of the power or force upon which the inevitableness of the order depends. In this way law and force become in language convertible terms; and we speak equally of the law of gravity and the force of gravity,—the laws of attraction and the force of attraction; and we say generally of a thing, that it has the force of law. Nevertheless, the term force has its own meaning, and specially includes or expresses the idea of causation independently of inevitableness. In its strictest sense it is that which compels to the course of events expressed in the law without reference to the formula or the order. Yet the term is used correlatively with the order expressed; so that order, law, and force equally express the same ideas of uniform sequence, fixedness, inevitableness, and an inevitably compelling force. Thus motion in a straight line implies both a force that impels, and an unchanging continuousness in the line of motion until an equal force interrupts or deflects. Starting from these generalizations of the words force and law, the author proceeds to show, that as the primary laws and forces are thus inevitable and fixed, the order which they compel and express can only be modified by equal forces acting according to like laws; since, logically, the inevitable alone can control itself. Hence, he concludes, that all these phenomena of nature which appear to be deviations from the primary forces and laws of nature (as the resistance to the force of gravity which the upright position of man implies, and the like) are in fact due to laws and forces derivative from the primary, and which are therefore secondary and contingent laws and forces. And since the phenomena of nature are all, in fact, deviations from one or two primary laws or forces, science may be defined to be a knowledge of these deviations from the primary laws and forces, formularized in contingent or derivative laws. Hence, too, the tendency of all the sciences to centre upon a few generalizations. It is, in fact, upon these ideas that the recent doctrines as to the correlations or the physical forces are substantially founded.

The author having called attention to these doctrines, shows that the generalizations he points out extend to sociology. Social laws must, as to society, be logically necessary laws, for without them society cannot exist. If the laws be not executed, society, as held together by law, ceases to exist, and is resolved into its elements. Hence all the laws of society whatever, whether written or implied, are necessarily correlative with a power or force sufficient to compel men to adopt their actions to the prescribed order. In this way we speak of the *force* of opinion in reference to the unwritten natural laws, and of the *requirements* of the law, just as we speak of the necessary laws of nature and the inevitable laws of God.

In determining the generalizations included in the word *mind*, the author observes that, when we speak of the law, or laws, in reference to the conduct of man in society, we not only have in view the fact that there is an order of events or actions to be followed, expressed in law, and a power to compel to that order, or obedience to the law; but we know as a fact of experience that the order is designed with regard to certain ends to be obtained, as *results* of the order. And we can go a step farther, and find that the designer (or designers) either is the force necessary to compel obedience to the designed order, or delegates it to others. In the great uniformities of nature we recognise a similar cause. When we speak of the necessary laws of those uniformities, we not only include a conception of the force which compels the uniformities, but we go beyond it in causation, and think of the something which both designed the order implied in the uniformities, and originated the compelling force. Now this is what men designate mind. It is the first cause in creation, as it is in man's actions. It follows, therefore, that a true mental science should set forth the correlations between mind as manifested in man, and mind as manifested in creation. In addressing himself to this task, the author points out, by way of preliminary remark, that the design must be carefully distinguished from the designer; and the law of design or the expression of the results of the order, from the thought or the thinker. If we examine the order of phenomena in creation, we can at least conceive (what is analogous to our own experience of our own mental processes and acts), that the whole order of creation was pre-existent in the Divine mind as a thought before the order itself began. But farther, we can also see the logical necessity, that when once the design was made it must be inevitable, for we find that the great laws of nature in which design is expressed are inevitable. Hence a mental law and a mental force both dominate, and are correlative with the physical laws and forces, or the forces of matter. So that there is no such thing in nature as chance; the word only implying the unknown to man as to order, law, and cause, and more especially applicable to derivative laws and forces. It follows, therefore, that what we term physical laws and forces are only lower generalizations of a primary mental law and force, and consequently correlative therewith. Motion and order are thought in act. So that the entire phenomena of creation are under the derivative laws and forces of mind.

Such a generalization implies, however, a change in the method of research. Experience is content to know what is the uniform succession or order of phenomena, and what are the laws and forces correlative therewith; but so soon as a law of design is the object of inquiry, it becomes necessary to examine the order of phenomena with regard to the ends arrived at in the order; that is, to determine the *results* of the uniform succession. Hence *teleology*, or the doctrine of final causes, is as applicable to both physical and biological researches as to the metaphysical, and must be considered the true guide to the highest researches in natural science, just as the law of design and mind subsume all other forces and laws.

Proceeding to apply the teleological method, the author next inquires what is the most general physical result in creation, or "Final cause" of the primary law of design and its correlative force. This result, he argues, must logically be at least the combination of things into wholes, or a whole, of mutually related parts; and such is practically the result in the physical as distinguished from the moral world, of both the general and the derivative laws and forces. The primary forces of matter operate to the *end* that the great masses of matter shall form wholes of mutually related parts, as in our planetary and other solar systems, and in the universe made up of systems; while the derivative laws and forces operating in life and organization, *result* in an *organism*, which, according to the definition of Kant, " is that in which all the parts are mutually ends and means."

Applying these doctrines to the primary law of consciousness, the author maintains that such a result of the law of design, aimed at and attained, may be designated in relation to the consciousness, the *idea* of unity; in relation to the external world, the *law* of unity. The law implies two things—construction of parts in mutual relation—or *organization;* and action of the parts in mutual relation as a whole, or *individual life.* The fundamental idea of consciousness—the intuition in man of the " I am," or Ego, is the ultimate result presented to the consciousness of these two things. It is the final cause of all those derivative or correlative laws and forces of the primary law of mind and primary forces of matter, which, operating in his body as " teleorganic " laws and forces, or vital laws and forces of adaptation to ends, build up his body into an organism.

In this way (the author proceeds to show) we arrive at the origin of all other necessary or intuitional truths, of which the conception of design itself is one of the most fundamental. The mind of man having thus the results of the great law of design presented to it as intuitive ideas, in virtue of the teleological operation in his organization of the physical and vital forces, must be potentially, and when fully evolved in correlation with organization, actually a microcosm. And it follows, from the correlation of the physical, vital, and mental forces of creation, that all the intuitive ideas of the human mind are to be discovered in the external world, as derivative results of the primary law of design; or, in other words, as ideas of the Great Thought manifested in creation. The author therefore maintains that such a true science of *ideology* or metaphysics as could be built upon these principles, would be fit to take its place at the head of all the natural sciences; for we can thereby attain to a criterion of absolute truth, and correct the dimly felt intuitions of our own consciousness, by comparing them with the fixed, immutable, and eternal conceptions of the Divine mind, as manifested in creation.

The author next proceeds to illustrate these views by special examples. Thus, in *psychology*, he shows that the will is an intuitive exercise of power according to the law of design. That pleasure is felt, and the condition is good, when the operations of the forces by which the organism is built up as a whole are in accordance with the ends arrived at, and with the order fixed for those ends; that, on the contrary, pain is felt, and the condition is evil when disorder arises, and the results are in disaccordance with the ends aimed at. It is necessary to bear in mind that the ideas included in general terms correlate each other in psychology as well as in physics. Thus Order, regard being had to its results, is logically correlative with Good; for good in creation is the result of order, and of order alone. Order, again, is as general a law as design; consequently the deviations from the primary law of design, known as evils, are correlative with, and derivative from the primary law of order, just as the physical and vital forces are derivative from the primary forces. Again, perfection correlates the law of order and the law of unity; for, admitting that there are degrees of perfection, the highest perfection is attained when, with the greatest multiplicity or differentiation of parts, there is the most complete unity, or adaptation of those parts to each other as ends and means. This is the perfection of society as well as of organisms.

In *biology*, the author shows that the laws of unity of type and permanence of species are compatible with an empirical law of life—the law of incessant change. The adaptation of an organism to the external world is instinct; but since the operations of the forces of the external world which maintain life, as heat, light, and the like, are constantly varying, so, according to the teleological law, must the phenomena of life and instinct be constantly varying. Hence, correlative with the fixed and immutable law of design, as manifested in unity of type, and derivative therefrom, is the law of incessant change; and this is a primary law of creation as well as of life. For, just as the motion of a planetary body round a centre or centres is due to incessant variations (as marked by every point in the described curve), caused in the line of direction by a deflecting force, so all the variations in organisms, whether animal or vegetable, from the first, or correlative law of design, as manifested in unity of type, are results of deflecting forces, *i. e.*, of external conditions, influencing organisms to change from the type in time and space. In this way, unity of type and permanence of species are correlative with incessant variations in the transmissions of the characters and instincts of the species, whether they be simply morbid, and known as hereditariness, or appear to give rise to new species.

The author finally shows, that as unity of structure implies unity of function, we have in these principles the foundation for an investigation of what has hitherto been considered wholly inscrutable, namely, the relations of the organization to the consciousness; or, in other words, the connection of body and mind. Mind is not merely inseparably associated with the primary forces of matter; it acts in and by them. Their phenomena are its signs. Hence, since the order of these phenomena and the action of the forces can be expressed numerically, it follows that the results or ends arrived at can be expressed numerically; or, in other words, the teleological laws can be reduced to numerical formula. This can be done already as to nutrition and development, and the *forms* of vegetables and animals; but since all the successional states of our consciousness correspond to successional vital states, occurring according to the teleological law of the physical and vital forces, it is clear that the signs which express the law of succession of the one series, might be made to correspond to the laws of succession of the other. In this way, the brain may be looked upon as the instrument whereby the mind is brought into immediate relation,—not with matter alone,—but with the forces of matter; and our intuitive cognitions may be considered as direct and immediate cognitions of the teleological operations of those forces in our organization.

2. Verbal Notice respecting the Remains of a Seal found at Portobello. By Dr Allman.

Professor Allman called attention to some bones discovered by Dr Andrew Balfour in a clay field near Portobello, and forwarded by him for presentation to the Museum of Natural History. They prove to be bones of a seal, and consist of some vertebræ, a portion of a scapula, a radius, a femur, and a fibula. They thus afford an additional instance to the few already recorded, of the occurrence of phocine remains in the British Islands. The deposit in which they occurred appears to belong to the period of the boulder clay. They were found about 20 feet above the present level of highwater, and about 15 feet below the surface of the soil.

3. On the Composition of Old Scotch Glass. By Mr Thomas Bloxam, Assistant Chemist to the Industrial Museum. Communicated, with a Preliminary Note, by Professor George Wilson.

We have recently been engaged in the laboratory of the Industrial Museum in executing some analyses of glass, which, as of general interest, I lay before the Society. The analyses in question have been made by Mr Bloxam, the official laboratory-assistant, and it is desirable first to mention with what object they were undertaken. I have limited the investigation in the first place to common bottle glass and window glass in use in Scotland, and so far as could be ascertained, also manufactured in Scotland. As yet we have only overtaken six varieties, and the full import of their analyses will not appear till additional examples have been examined. The following statement aims at nothing more than the establishment of certain data in the glass-manufacture :—

In the case of window-glass, I was anxious to obtain a specimen manufactured before the introduction of the process now so largely followed for the conversion of common salt into soda-ash, the form of alkali now used by the maker of window-glass. Through the assistance of my friend, Mr James Young, I obtained such a specimen. It constituted part of a window-pane, known to have been procured from the Dumbartonshire Glass-Works, and originally employed in glazing a house in Russell Street, Glasgow, built some forty years ago.

Mr John Young, who died last December, aged eighty-five, remembered the building of the house, and knew the source of the glass. He superintended the cutting out of the glass, which was taken from an upper pane, as less likely than a lower one to have been introduced to replace a broken sheet of earlier date. He could also testify that the putty was that originally employed in fixing the pane.

From the analysis it will be seen, that unlike our later window-glass, it contains potash as well as soda. In all probability the alkali used in its manufacture was kelp, which contains both alkalies, and was the chief source of soda to the Scotch glass-maker and soap-maker, till the salt process was established. The glass is inferior in the important quality of colourlessness to the window-glass now manufactured, a defect not explicable by a reference to the presence of potash, which has a less colouring influence on glass than soda. The green tint so manifest is sufficiently explained, however by the large amount of oxide of iron discovered on analysis. Of dark bottle-glass, specimens abundantly authentic were obtained from the relics of Dr Joseph Black's apparatus. They were probably made at Leith, where ordinary bottles have been manufactured for a long period from clay, sand, salt, and other cheap materials of the neighbourhood. Newcastle, however, has long directed much of the bottle-making to herself, and still more recently Belgium is injuring the trade at Newcastle. In contrast with this I have obtained examples of Chance's glass, made by simply melting ragstone or basalt, the revival of an old French mode of glass-making, extended by the English manufacturer to the production of glass tiles, vases, and large slabs. Could our native trap-rocks be at once melted into available glass, it would be an important addition to the industrial manufactures of the country; but the relinquishment at Birmingham of the basalt process, as unremunerative and impracticable, is not encouraging.

The window-glass from Dunfermline Abbey was given by Dr John A. Smith, a zealous member of the Society of Antiquaries. Dr Smith writes in reference to it—"It was picked up by Bailie Mitchell of Dunfermline, in November 1818, when various diggings were made above the ruins of the old Abbey, preparatory to the rebuilding of the church, and it was said to have been found closely adjoining the site of the great east window of the Abbey.

"Bailie Mitchell gave it to an antiquarian acquaintance of mine, from whom I received it."

The exact age of the glass is thus unknown, and the place of its manufacture quite uncertain. It is, however, certainly old and historically interesting.

Regarding the Abbey, Mr John Stuart, Secretary of the Society of Antiquaries, furnishes the following information:—

"Queen Margaret founded a church at Dunfermline immediately after her marriage in 1070. It was probably of temporary description; and a church completed by David I. was dedicated in 1150."

At the translation of Queen Margaret's relics in 1250, a new church is spoken of, which seems to have consisted in an enlargement of the choir of the previous church, so that the date of foundation and addition would be 1150 and 1250."

The glass from Dunfermline Cathedral was given me by the sexton, as having fallen from the windows, and had been long in his possession.—G. W.

The specimens of glass submitted to investigation were six in number, namely, four window-glasses, one bottle-glass, and one basalt-glass.

1. Window-glass from Dumbartonshire.
2. Fragments from a window in Dunfermline Abbey.
3 and 4. Fragments of window-glass from Dunblane Cathedral.
5. A bottle from the laboratory of Dr Joseph Black.
6. Basalt-glass, manufactured by the Messrs Chance and Co.

Where the quantity of material was sufficient, the following points were determined with each specimen.

1° Specific gravity.
2° Solubility in water.
3° Solubility in alkalies.
4° Solubility in acids.
5° Quantitative composition.

The method of examination was that employed by most chemists for the analysis of silicates, namely, fusing the substance with carbonate of potash and soda, dissolving the fused mass in acid, and estimating the substances in solution. The solvent action of water, acids, and alkalies was ascertained by subjecting the specimen, in fine powder, to each of these menstrua, for some days, and in most cases analysing the liquid containing the soluble part of the glass, The specific gravity was determined in the usual manner practised in the laboratory, a mean number being deduced from the results of three experiments.

Dumbartonshire window glass had a specific gravity of 2·55.

Water dissolved substances from it to the amount of ·14 of a grain per cent., consisting mainly of silica, together with lime, iron, alumina, magnesia, and soda in smaller quantities.

Potash dissolved the glass to the extent of ·76 of a grain per cent.

The quantitative composition of Dumbartonshire glass is the following:—

Silica, . . .	65·51
Protoxide of Iron, .	3·68
Alumina, . .	3·67
Soda, . . .	10·75
Potash, . .	5·55
Lime, . .	10·42
	99·58

Ratio of oxygen in the bases to that in the silica as 3 to 11.

The specimen of Dumfermline Abbey glass was too small to allow of any characters beyond the specific gravity and chemical composition being ascertained. The specific gravity was found to be 2·63; chemical composition to be,—

Silica, . . .	44·47
Protoxide of Iron, .	4·98
Alumina, . .	12·21
Lime, . . .	17·23
Magnesia, . .	3·81
Soda, . . .	13·90
Potash, . .	3·20
	99·80

Ratio of the oxygen in the bases to that of the silicic acid as 3 to 4.

The third and fourth specimens examined were from Dunblane cathedral windows.

They were of a blue colour, the first being the darker in tint, and were too small to admit of complete examination.

The first sample had a specific gravity of 2·63, and consisted of,

Silica, . . .	62·70
Protoxide of Iron, .	1·26
Alumina, . .	2·60
Lime, . . .	6·25
Oxide Copper, .	4·99
Potash, . .	·80
Soda, . . .	21·40
	100·00

Ratio of oxygen in bases to that of the silicic acid as 3 to 10.

The second specimen had a specific gravity of 2·47 and chemical composition as follows:—

Silica, . . .	49·66
Protoxide Iron, .	6·60
Alumina, . .	11·52
Lime, . . .	19·25
Oxide of Copper, .	1·32
Potash, . .	1·53
Soda, . . .	10·09
	99·97

Ratio of oxygen in bases to that of silicic acid as 3 to 5.

The next specimens submitted to investigation, was a bottle used by Professor Black for chemical purposes.

The specific gravity was 2·75.

Water was found to dissolve from it ·22 of a grain per cent., consisting of lime, oxide of iron, silica, and magnesia.

Hydrochloric acid dissolved substances to the amount 2·82 per cent., and potash, ·56 of a grain per cent.

The glass had the following composition :—

Silica, . . .	56·90	Ratio of oxygen in bases to that of silicic acid as 1 to 2.
Protoxide of Iron, .	3·61	
Alumina, . .	10·22	
Lime, . . .	25·80	
Potash, . .	1·90	
Soda, . . .	1·55	
	99·98	

The last sample made the subject of analysis was the so called basalt glass of Messrs Chance and Co.

It is produced by the mere fusion of basalt, is very hard, and of a black colour.

The specific gravity was ascertained to be 2·709.

Water dissolved ·34 of a grain per cent., consisting of silica, protoxide iron, lime, and magnesia.

Hydrochloric acid dissolved 3·4 per cent., and potash 1·44 per cent.

The composition of the basalt glass may be thus represented :—

Silica, . . .	54·88	Ratio of oxygen in bases to that of silicic acid as 1 to 2.
Protoxide Iron, .	17·83	
Alumina, . .	11·54	
Lime, . . .	9·26	
Potash, . .	1·05	
Soda, . . .	5·34	
	99·90	

Action of Solvents upon the foregoing varieties of Glass.

		Action of Water.	Action of Hydrochloric Acid.	Action of Potash.
I.	Dumbartonshire glass, . . .	Dissolved ·14 of a grain per cent.	Dissolved ·72 of a grain per cent.	Dissolved ·76 of a grain per cent.
II.	Dunfermline Abbey glass, . .	Too small for experiment.	... ...	... ...
III. IV.	Dunblane glasses, ...	Do. Do.	... ...	... ...
V.	Black's glass, ...	Dissolved ·22 of a grain per cent.	Dissolved 2·82 grains per cent.	Dissolved ·56 of a grain per cent.
VI.	Basalt glass, ...	Dissolved ·34 of a grain per cent.	Dissolved 3·4 grains per cent.	Dissolved 1·44 of a grain per cent.

Chemical Composition.

	I.	II.	III.	IV.	V.	VI.	Specific gravity.
Silica, ...	65·51	44·47	62·70	49·66	56·90	54·88	I. 2· 55
Protoxide Iron, ...	3·68	4·98	1·26	6·60	3·61	17·83	II. 2· 63
Alumina, ...	3·67	12·21	2·60	11.52	10·22	11·54	III. 2· 63
Lime, ...	10·42	17·23	6·25	19·25	25·80	9·26	IV. 2· 74
Magnesia.	...	3·81	...	...	...	...	V. 2· 75
Oxide Cobalt, ...	...	...	4·99	1·32	...	...	VI. 2·709
Potash, ...	5·55	3·20	·80	1·53	1·90	1·05	..
Soda, ...	10·75	13·90	21·40	10·09	1·55	5·34	. .
	99·58	99·80	100·00	99·97	99·98	99·90	
Ratio of Oxygen in bases to that of Silica,	3:11	3:4	3:10	3:5	1:2	1:2	

The following Gentleman was elected an Ordinary Fellow:—

Lieutenant JOHN HILLS, Bombay Engineers.

The following donations to the Library were announced:—

Note sur la Comète de Donati, par M. E. Plantamour. 8vo.—*From the Author.*

Résumé Météorologique de l'années 1855, 1856, et 1857, pour Genève et le Grand Saint-Bernard, par M. E. Plantamour. 8vo.—*From the Author.*

Observations Astronomiques faites a l'Observatoire de Genève, dans les années 1851 et 1852, par M. E. Plantamour. 4to.—*From the Author.*

De la Température a Genève d'apres vingt années d'Observations 1836 á 1855, par M. E. Plantamour. 4to.—*From the Author.*

Sketch of the Civil Engineering of North America, by David Stevenson, F.R.S.E. 8vo.—*From the Author.*

Mémoires de la Société Impériale des Sciences Naturelles de Cherbourg. Tome V. 1857. 8vo.—*From the Society.*

Transactions of the Royal Society of Literature. Vols. I., II., III., IV., V., and Part I., Vol. VI. 8vo.—*From the Society.*

Occasional Papers on the Theory of Glaciers, with a Prefatory note on the Recent Progress and present aspect of the Theory, by James D. Forbes, D.C.L., F.R.S., &c. 8vo.—*From the Author.*

Bulletin de la Société des Sciences Naturelles de Neuchatel. Tome IV., Cahier III. 8vo.—*From the Society.*

Bulletin de la Société de Geographie, Tome XVI. 8vo.—*From the Society.*

Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Tome XIV., 2^{e} parti. 4to.—*From the Society.*

Untersuchungen über die Rechtung und Stärke dis Erdmagnetismus an verschiedenen puncten des Südwestlichen Europa. Von Dr J. Lamont. 4to.—*From the King of Bavaria.*

Abhandlungen der Kœniglich Bayerischen Akademie der Wissenschaften. Philos-philologischen Classe, Vol. VIII., Abth. 3. Math-physicalischen Classe, Vol. VIII., Abth 2. Historischen Classe, Vol. VIII., Abth 2. 4to.—*From the Academy.*

Gelehrte Anzeigen. Vols. XLVI. and XLVII. 4to.—*From the same.*

Über die geschichtlichen Vorstufen du neuern Rechtsphilosophie. Von Prof. Dr Carl Prantl. 4to.—*From the same.*

Über Neuaufgefundene Dichtungen. Francesco Petrarca's. Von Prof. Dr G. M. Thomas. 4to.—*From the same.*

Über Johannes Muller und sein Verhaltnis zum jetzigen. Standtpunkt der Physiologie. Von Dr Th. L. W. Bischoff. 4to.—*From the same.*

Catalogus Codicum Manu Scriptorum Bibliothecæ Regiæ Monacensis. Tomus VII. 8vo.—*From the same.*

Lighthouse Illumination: being a Description of the Holophotal system, and of Azimuthal-condensing, and Apparent Lights, with other Improvements. By Thomas Stevenson, F.R.S.E. 8vo.—*From the Author.*

Monday, 4th April 1859.

PROFESSOR CHRISTISON, Vice-President in the Chair.

The following Communications were read:—

1. On the Gradual production of Luminous Impressions on the Eye. Part II. By Professor Swan.

The author, in a paper communicated to the Royal Society of Edinburgh in 1849,* described a method of observation by which he had succeeded in measuring the brightness of visual impressions of short duration. This consisted in causing a disc, with a sector of a known angle cut in it, to revolve with a known uniform velocity between the eye and a luminous object. At each revolution of the disc a flash is seen. The time during which the light has acted on the eye is easily computed from the angle of the sector and velocity of the disc; and the brightness of the flash is ascertained by photometric arrangements. By this method the brightness of impressions formed on the eye by light acting for short intervals of time varying from ·1 to ·001 of a second was ascertained with results which have been described in the paper already referred to.

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* Edinburgh Transactions, vol. xvi, p. 581.

It seemed desirable to extend the observations to impressions formed on the eye in intervals of time still shorter than ·001 of a second; and it may seem that this could be accomplished, either by diminishing the angle of the sector, or by increasing the diameter or velocity of rotation of the disc. There are obviously, however, limits to the narrowness of the sector, and to the diameter of such discs as can be used conveniently; and the velocity with which the disc may be driven is also limited, for when the number of revolutions exceeds about ten in a second, the successive impressions, which it is proposed to observe separately, become blended into a single nearly uniform impression, owing to their persistence on the retina. The instrument now described to the Society is devised for the purpose of separating a *single* impression out of the multitude of impressions made by a rapidly revolving disc, so as to render it possible to observe the brightness of isolated visual impressions formed by light acting on the eye for extremely short intervals of time.

The instrument consists of a train of wheels and pinions by which a disc having a sector cut in it is driven with great velocity. The numbers of teeth in the wheels and pinions are so arranged that each wheel, as well as the disc, makes ten revolutions for one revolution of the wheel by which it is driven. Each of the two last wheels of the train, which are of solid metal, has a hole pierced in it, through which light transmitted by the sector can pass to the eye; and the wheels are so placed that at each hundredth revolution of the sector, and only then, the sector in the disc and the holes in the wheels come into the same straight line, so that the eye of the observer receives a single flash transmitted through the holes in the wheels. The result of this arrangement is, that although the disc be driven at the rate of a hundred revolutions per second, so that the impressions produced by the successive flashes transmitted by it when seen by the unassisted eye would be blended into an uniform impression, yet the observer, looking through the holes in the wheels, receives only a single flash of light once a second. The brightness of the observed isolated flashes may be ascertained by photometrical means, similar to those employed by the author for the same purpose in 1849, and which he has fully described.

An Instrument for producing Isolated Luminous Impressions of extremely short duration, varying from one-tenth to one millionth of a second, was shown.

2. On the Destructive Effects of the Waves of the Sea on the North-East Shores of Shetland. By Thomas Stevenson, C.E., F.R.S.E.

The author stated, that the present communication might be regarded as supplementary to the one describing the results of his marine dynamometer, which would be found in the 14th volume of the "Transactions." On the Bound Skerry of Whalsey, which is only exposed to the waves of the North Sea or German Ocean, he had found, on first landing in 1852, masses of rock, weighing 9½ tons and under, heaped together by the action of the waves at the level of no less than 62 feet above the sea; and others, ranging from 6 to 13½ tons, were found to have been quarried out of their positions *in situ*, at levels of from 70 to 74 feet above the sea. Another block of 7$\frac{7}{16}$th tons, at the level of 20 feet above the sea, had been quarried out and transported to a distance of 73 feet from S.S.E. to N.N.W. over opposing abrupt faces as much as 7 feet in height. Somewhat similar evidences of the force of the sea were observed on the neighbouring islands, and more recently by Mr David Stevenson at Balta and Lambaness (in the most northern of the Shetland Islands), who, in a report made at the time, attributed the great force of the waves in the northern regions of the German Ocean to their exposure and the proximity of deep water to the land. In addition to these causes, the author referred to the strength of the tides, the configuration of the German Ocean, and to the great general depth of the water, as the probable causes why heavier waves are produced in the latitude of Shetland than are found, for example, on the coasts of England or Holland. The author, after alluding to the writings of Mr Airy and Mr Webster, referred, in particular, to this gradually decreasing general depth in passing from Shetland to Holland, as a main cause of the diminished magnitude of the undulations. That the waves are materially smaller in the southern than in the northern latitudes, may be inferred from the low, yet safe, level at which many of our southern sea-port towns have been built in reference to that of high water. The author considered that another proof that this reduction of the waves depended on the reduction in the depth of water, might be deduced from the structure of the bottom. He considered that the presence of *mud* at any depth might be taken as a certain proof that the agitation, originating at the surface, had ceased to be appreciable. If the geological formation did not produce a clayey deposit, or if strong submarine currents existed, the *absence* of mud might afford no proof of the magnitude of the waves; but its *presence* in shoal water may be relied on as indicating with certainty that in whatever locality it is found there must be small disturbance at the surface, or, in other words, that there cannot be a heavy sea. Applying such a *test* to the present case—muddy deposits are found in from 80 to 90 fathoms off Whalsey, from which point southwards they are found in gradually lessening depths, till they rise to within 8 fathoms of the surface at the mouth of the Elbe. Similarly, at the Firth of Forth, the mud rises on the north side from 18 fathoms off Elie Ness to 7 at Burntisland; and on the south side, from 17 fathoms, near North Berwick, to 2 fathoms off Leith; while above Queensferry, even although the current is stronger in the higher portions of the estuary, the mud, owing to the comparative absence of waves, actually emerges above low water. It is well known, that on the banks of Newfoundland, and all round the British islands, where the bottom suddenly rises near the 100 fathoms line, the waves actually break. It seems reasonable, therefore, to infer, that the gradually decreasing depth of the German Ocean must as effectually, though not so suddenly, diminish the size of the undulations.

3. Notice of an Unusual Fall of Rain in the Lake District, in January 1859. By John Davy, M.D., F.R.SS. Lond. and Edin.

Whilst the average fall of rain during the preceding six years in January has been at Ambleside 4·22 inches; in this month, in the current year, the rain measured has amounted to 14·82 inches.

The quantity of rain that has fallen in other localities of the district during the same month is stated in a table, in which also is included the rain-fall in some other parts of the United Kingdom. In the former, it has ranged from 14·375 to 6·514 inches, diminishing with distance from the central mountains; in the latter, the range has been from 6·48 inches to 0·36 inch, diminishing, it would seem, with distance from the western coasts.

In another table some other instances of extraordinary rain-falls are given which occurred in the Lake District at Coniston and Ambleside, varying from 12 to 24·39 inches in a month.

A third table is appended, showing the quantity of rain monthly that has fallen at Seathwaite in Borrowdale during fourteen years; from which it appears that the maximum fall monthly has been 32·83 inches, and yearly 160·55 inches.

In connection with the rain-fall, other meteorological observations are offered, illustrative of the peculiarities of the last year and of the present season; of which, as regards the last, the most remarkable are, a prevalency of westerly winds, exceeding mildness, and a precocious spring; vegetation in the first week in March being at least a month in advance.

The following Donations to the Library were announced:—

Eroffnungorede der 43 sten Versammlung, Schweizerischen Naturforscher in Bern durch den Presidenten. Prof. Dr B. Studer. 1858. 8vo.—*From the Author.*

Atti del' imp. Reg. Instituto Veneto di Scienze, Lettere ed Arti. Dal Novembre 1858 all' Ottobre 1859. Tomo IV. Dispensa 4to. 8vo.—*From the Institute.*

Die Fortschritte der Physik im Jahre 1856. Dargestellt von der Physikalischen Gesellschaft zu Berlin. XII. Jahrgang. 1 Abth. 8vo.—*From the Society.*

Proceedings of the Academy of Natural Sciences of Philadelphia. 1858. Nos. 10–20. 8vo.—*From the Academy.*

The Mosiac Account of the Creation. By James C. Fisher, M.D. 8vo.—*From the Author.*

Review of Marcou's "Geology of North America." By James D. Dana. 8vo.—*From the Author.*

On Marcou's "Geology of North America." By Prof. Agassiz. 8vo.—*From Prof. Dana.*

Notes on the Currents of the Ocean. By James D. Dana. 8vo.—*From the Author.*

Observations on the Genus Unio. By Isaac Lea, LL.D., Vol. VI. Part II. 4to.—*From the Author.*

Papers from the Proceedings of the Academy of Natural Sciences of Philadelphia. - By Isaac Lea. 8vo.—*From the Author.*

Account of the Remains of a Fossil Extinct Reptile recently discovered at Haddonfield, New Jersey. 8vo.—*From Dr I. Lea.*

Proceedings of the Royal Medical and Chirurgical Society of London, Vol. III., Part I. 8vo.—*From the Society.*

Journal of the Asiatic Society of Bengal. No. 269. 8vo.—*From the Society.*

Monday, 18*th April* 1859.

PROFESSOR CHRISTISON, Vice-President, in the Chair.

The following Communications were read:—

1. Researches on Radiant Heat. Part II. By Balfour Stewart, Esq. Communicated by the Secretary.

The first part of this paper describes the following groups of experiments:—

I. On the effect which roughening the surface of a body produces upon its radiation.

II. On the nature of that heat which is radiated by rock-salt at at 212° F.

III. On the radiation of glass and mica at high temperatures.

The second or theoretical portion of the paper has reference to the law which connects the radiation of a particle with its temperature, and to Dulong and Petit's experiments on this subject. The instruments used, and method of using them, were almost the same as described in the first series of these researches.

With regard to the first group of experiments, it was ascertained that roughening surfaces of glass or rock-salt with emery paper until they are dim for light, neither alters the quantity nor the quality of the heat which they radiate; the surface, although dim for light, being yet specular for heat.

With regard to the second group of experiments, it was shown that heat from rock-salt at 212° F. penetrates a screen of glass or mica less easily than lamp-black heat at 212° F.

It also penetrates a screen of mica split by heat less easily than the latter description of heat; but the difference of behaviour of the two kinds of heat with regard to this substance is not so marked as in the case of ordinary mica.

So far as tested by mica, and mica split by heat, it was shown that,—

Lamp-black heat of 700° F. bears to
Lamp-black „ 212° F., the same relation as
Lamp-black „ 212° F. bears to
Rock-salt „ 212° F.

that is to say, rock-salt heat possesses greater average wave-length than lamp-black heat.

With regard to the third group of experiments, it was shown that glass or mica, by being heated, does not change in any measure its capacity for transmitting a given description of heat; for instance, cold glass transmits heat of 700° F. just as well as glass heated to 700° F. does. Proceeding, then, to the theoretical part of the paper, it was then shown that, owing to the following facts:—

1*st*, That the absorptive power of a thin plate of any substance equals its radiative power.

2*d*, That (by the third group of experiments) the absorptive power of cold glass for heat of 700° F., is the same as that of glass heated to 700° F.

3*d*, That cold glass has a greater transmissive, or less absorptive power for heat of 700° F., than for heat of 212° F.

we must conclude that "the radiation of a thin plate of glass, or other substance, at 700°, bears a less proportion to the total radiation of 700° F., than its radiation at 212° does to the total radiation of 212° F. It was also shown that this difference is more marked for a thin plate than for a thick one; and it was argued, that Dulong and Petit's law does not express the law of radiation of a material particle, but that this law, whatever it be, increases (for all bodies) less rapidly with the temperature than Dulong and Petit's law.

2. Some Observations on the Coagulation of the Blood. By John Davy, M.D., F.R.S. Lond. and Edin.

Dr Richardson, in a recent and elaborate work on the blood, an extension of a Prize Essay on the cause of the coagulation of this fluid, has endeavoured to prove that this phenomenon is of a chemical kind, depending on the escape of the volatile alkali.

The author of the paper of the above title describes three sets of experiments which he has instituted for the purpose of testing Dr Richardson's hypothesis. In all his trials on blood, he has used that of the common fowl, its properties being best adapted to the objects in view. The results obtained were briefly the following:—

1. Ammonia added to the blood in small quantities did not prevent its coagulation; in larger quantities it retarded coagulation, and rendered the blood viscid.

2. On exposing mixtures of blood and ammonia, and of water and ammonia, to the open air, the loss of weight sustained in two or three minutes—the time required for the coagulation of the blood—was hardily appreciable, using a very delicate balance.

3. The moist fibrin of the blood subjected to the action of ammonia was found to be rendered transparent and viscid; but to be very slightly soluble.

These results, and others, such as the coagulation of the blood in close vessels, and the volatile alkali not having hitherto been detected in healthy blood, have led the author to the conclusion that the phenomenon under consideration still remains an unsolved problem; and that on the ground of mere probabilities it is not easy to say which of the two chief hypotheses advanced concerning it—the chemical and the vital—is deserving of preference.

3. On the Recent Vindication of the Priority of Cavendish as the Discoverer of the Composition of Water. By Professor George Wilson.

The object of this communication was to direct attention to the recent recovery of two documents establishing the priority of Cavendish as the discoverer of the composition of water. Their importance was indicated by the late Mr Robert Brown, the botanist, and his literary executor, Mr J. J. Bennett of the British Museum, has brought them before the Royal Society of London. They are both, contrary to general expectation, published statements contained in well-known works. The first is a section of De Luc's "Ideés sur la Météorologie," entitled, "Anecdotes relatives à la découverte de l'Eau sous la forme d'Air," in which the following decisive declaration occurs :—

"Vers la fin de l' année 1782, J'allai à *Birmingham* ou le Dr Priestley s'étoit établi depuis quelques années. Il me communiqua alors, que M. Cavendish, d'apres une remarque de M. Warltire; qui avoit toujours trouvé de l'*eau* dans les vases où il avoit brûlé un mélange *d'air inflammable* et d'air atmospherique; s'étoit appliqué à découvrir la source de cette eau, et qu'il avoit trouvé, 'qu'un mélange *d'air inflammable* et *d'air dephlogistiqué* en proportion convenable, étant allumé par l'étincelle électrique, se convertissoit tout entier en *eau.*' Je fus frappé, en plus haut degré, de cette découverte." (*Idées*, &c., tome ii., 1787, pp. 206–7.)

The important testimony thus borne to Cavendish's experiment having had as its object the discovery of *the source* of the water which appeared when hydrogen and oxygen are burned together; as its phenomenal result that in certain proportions *a given weight of the gases* in question could be burned into *the same weight of water;* and as its logical induction that *the gases had been converted into the water*, constituted Cavendish *a* discoverer of the composition of water. And as this conclusion was drawn in 1782, whilst Watt, the earliest counter-claimant of the discovery, did not draw his similar conclusion till 1783, the priority unquestionably belonged to Cavendish, who was thus *the* discoverer of the compositeness of water.

Reference was then made to the effort of Mr Muirhead to undervalue De Luc's testimony, on the plea that in another part of the "Idées" its author declared himself to have been ignorant of Cavendish's conclusions till 1783, and not to have learned them till after he was familiar with those of Watt. It was contended, on the other hand, that De Luc's two statements were not contradictory, but perfectly reconcileable with each other,—the one referring to Cavendish's interpretation of his experiments on firing hydrogen and oxygen, which De Luc learned from Priestley in 1782; the other to

Cavendish's full theory of the formation of water, which was not made public till January 1784, and which it could be shown by the Watt Correspondence De Luc did not become acquainted with till March of that year.

Special attention was drawn to the fact, that the section of De Luc's "Idées" from which the quotation was taken went over the same ground as the Watt Correspondence. This section contained the matured and authoritative publication of those views on the relative merits of Watt and Cavendish which are referred to by De Luc in the hasty private letters printed in the "Correspondence" in question, written when he was imperfectly informed on the points he was discussing, and not intended for publication. The author dwelt upon the omission of Mr Muirhead, when editing the Watt Correspondence, to point out this important fact to his readers, and the misleading effect of this omission in representing De Luc as much more the advocate of Watt's claims than in reality he was. In many respects the "Idées" supplemented the Watt Correspondence so far as the views of De Luc were concerned, and the latter work could not be understood unless read in the light of the former.

The second of the recovered documents was an extract from a Report to the French Academy, on M. Seguin's experiments on the Combustion of Hydrogen and Oxygen, dated 28th August 1790, written by La Place, in name of a Commission consisting, besides the reporter, of Lavoisier, Brisson, and Meusnier, all of whom sign it. The passage of most importance, as showing that Lavoisier abandoned in favour of Cavendish the claim he at one time preferred to be the discoverer of the composition of water, is as follows:—

"M. Macquer a observé dans son Dictionnaire de Chimie que la combustion des gaz hydrogène et oxygène produit une quantité d'eau sensible; mais il n'a pas connu toute l'importance de cette observation, qu'il se contenta de présenter, sans en tirer aucune conséquence. M. Cavendish paroît avoir remarqué le premier que l'eau produite dans cette combustion est le résultat de la combinaison des deux gaz, et qu'elle est d'un poids égal au leur. Plusieurs expériences faites en grand et d'une manière très-précise par MM. Lavoisier, La Place, Monge, Meusnier, et par M. Lefevre de Gineau, ont confirmé cette découverte importante, sur laquelle il re doit maintenant rester aucun doute." (*Annales de Chimie*, tome viii., pp. 258–9.)

In conclusion, the author dwelt upon the brightened moral aspect of the water controversy. From De Luc's "Idées" all trace of charge against the fair-dealing of Cavendish has vanished. Lavoisier is found making full, if somewhat tardy, amends for any wrong he did the English philosopher, and as De Luc and Lavoisier testify that Cavendish had reached his famous discovery in 1782, the most uncharitable must cease suspecting that he borrowed or stole it from Watt, who had it not to offer any one till 1783.

4. On the Preservation of Foot-prints on the Sea Shore. By Alexander Bryson, Esq.

The author remarked, that the impressions of the feet of birds and molluscs on wet sand, were liable to be effaced by the return of the tide; and that their preservation was owing to dry sand blown into the depressions from the shore, and again covered by a layer of moist sand or mud by the return of the tide. In regard to tracks left by gasteropodous molluscs, he stated that great caution was necessary to distinguish them from those left by Nereids; and instanced the case of a foot-track of a common whelk resembling the marks made by the Crossopodia on the Silurian slates. When the track of the whelk is filled up by the dry sand blown into the depression in the *line* of progress, no difficulty is felt in recognising it as the track of a gasteropod; but should the wind blow at right angles to the track of the mollusc, a series of setæ-like markings will be observed to leeward, caused by the dry sand adhering to the moist. In this instance, a geologist would naturally assign the markings to the impression of *Graptolites priodon*, or *sagittatus*; and if the wind suddenly shifted to the opposite direction, another series of setæ would be found on the other side of the mollusc's track, and the observer would at once pronounce the marks due to a gigantic Crossopodia, or fringe-footed Annelide.

The author also stated, that the so-called rain-marks found on sandstone and Silurian slates were formed by Crustacea, and that the cusps which geologists had supposed were the evidence of the force and direction of the wind during the shower, were produced by the wind blowing dry sand from the shore, and causing a raised barrier to leeward of the depression, where there was more moisture, and consequently more adhesion of the sand.

The following Donations to the Library were announced :—

Proceedings of the Natural History Society of Dublin for the Session 1857–58. Vol. I., Part 2. 8vo.—*From the Society.*

Einleitung in das Studium der Physik und Elemente der Mechanik von B. Studer, Professor, Bern. 8vo.—*From the Author.*

The Assurance Magazine and Journal of the Institute of Actuaries. No. 35. 8vo.—*From the Institute.*

Astronomical and Meteorological Observations, made at the Radcliffe Observatory, Oxford, in the year 1857. 8vo.—*From the Radcliffe Trustees.*

Journal of the Proceedings of the Linnean Society. Vol. III. No. 12. 8vo.—*From the Society.*

The American Journal of Science and Arts. Conducted by Professors Silliman and Dana. March 1859. 8vo.—*From the Editors.*

Englischer Liederschatz von Karl Elze. 32mo.—*From M. K. Elze.*

Westward, Ho! Britisch and Amerikanische Gedichte übersetzt von Karl Elze. 32mo.—*From the same.*

Shakespeare's Hamlet. Herausgegeben von Karl Elze. 8vo.—*From the same.*

Atlantis : Zeitschrift fur Leben und Literatur in England and Amerika. Herausgegeben von Karl Elze. Vols. I. and II. 8vo.—*From the same.*

Results of the Astronomical Observations made at the Royal Observatory, Greenwich, 1857. 4to.—*From the Royal Society, London.*

Jahrbuch du Kaiserlich-Koniglichen Geologischen—Riechenstalt. 1858. Nos. 1 and 2. 8vo.—*From the Society.*

Catalogues of Zoology. Published by the Trustees of the British Museum. 113 publications.—*From the Museum Trustees.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. IV. 1859–60. No. 50.

Seventy-Seventh Session.

Monday 28*th November* 1859.

Dr CHRISTISON, V.P., in the Chair.

The following Council were elected:—

President.

Sir T. MAKDOUGALL BRISBANE, Bart., G.C.B.

Vice-Presidents.

Sir David Brewster, K.H.
The Right Rev. Bishop Terrot.
Dr Christison.
Professor Kelland.
Hon. Lord Neaves.
The Very Rev. Dean Ramsay.

General Secretary—Professor Forbes.

Secretaries to the Ordinary Meetings—Dr Balfour, Dr Lyon Playfair.

Treasurer—J. T. Gibson-Craig, Esq.

Curator of Library and Museum—Dr Douglas Maclagan.

Councillors.

John Hill Burton, Esq.
David Stevenson. Esq.
Wm. Thos. Thomson, Esq.
Dr Allman.
The Duke of Argyll.
Andrew Murray, Esq.
Rev. Dr Lee.
D. Milne Home, Esq.
Professor C. Innes.
Dr Lowe.
Professor W. J. M. Rankine.
James Dalmahoy, Esq.

Monday, 5th December 1859.

1. At the request of the Council, Lord NEAVES, V.P., delivered the following Opening Address:—

It has been customary for those who have opened the business of the Session in the Royal Society, from the seat which I now occupy, to give some notice of those members who may have been taken from us by death during the preceding year. The rolls of the Society still exhibit many names illustrious both in science and in literature, but seldom has a year occurred in which we have been deprived of so great a number of eminent members. The first whom I shall mention is Principal Lee:—

John Lee, late Principal of the University of Edinburgh, was one of the most remarkable and estimable men of his time. His intellectual qualities were of a high order; his attainments and acquisitions of knowledge were of the most varied and extensive kind. On almost all subjects he was admirably well informed, and in some departments he was unquestionably the most learned man of his age and country. He was more than all this: he was a most pious Christian minister, and he was one of the most friendly and affectionate of men.

Dr Lee was born at Torwood-lee-Mains, in the parish of Stowe, on the 22d of November 1779. He received his early education from the care of his mother, whom he was accustomed to speak of as a woman of remarkable intellectual powers and mental cultivation, as well as of distinguished moral excellence. The debt of gratitude which he owed to his parents must indeed have been great, if it bore any proportion to the filial reverence and devotion which he showed them in every form in after life.

He was sent, when a boy of ten years old, to Cadon Lee School, at Clovenford, then taught by Mr James Paris, and in which, during Dr Lee's attendance, Doctor Leyden was an assistant. From that school he went to the University of Edinburgh in 1794, being then in his fifteenth year. In his opening address to the University, as Principal, in 1842, he refers to its state when he became a student, and recurs with pride and pleasure to the eminent men who then gave and received instruction within its walls. He continued at the

University for ten years, having studied both medicine and theology. He took the degree of M.D. in 1801, when his Graduation Thesis was much admired for its Ciceronian Latinity. He was licensed as a probationer of the Church in 1804.

During his attendance at college, he assisted Professor Robison in editing Dr Black's "Lectures on Chemistry." In 1802, before his college career closed, he was offered and he accepted the chair of Moral Philosophy in the University of Wilna, in West Russia, in which also, I believe, two other distinguished men were invited to become Professors—Thomas Campbell, the author of "The Pleasures of Hope," and Sir David Brewster, who has now succeeded Dr Lee in the office of Principal in our own University. It is but fair to say that these invitations were made through the medium of the late David Earl of Buchan, who, with some peculiarities of character, was a man of talent and taste, and inspired by a sincere zeal for the advancement of literature and science. Dr Lee prepared himself for fulfilling the duties of this appointment by writing out in Latin a portion of the lectures which he proposed to deliver at Wilna, but the arrangement was broken off by political events which interfered with its completion.

For some time previous to the end of 1805, Dr Lee had been on intimate terms with Dr Carlyle, well known as an eminent clergyman of the Church of Scotland, and then minister of Inveresk, near Edinburgh. He lived a good deal with Dr Carlyle, both at Inveresk Manse and in the Doctor's town residence; and as Dr Carlyle was then about eighty years of age, and still intimate with those of his own contemporaries, who were alive, such as John Home and Adam Fergusson, who belonged, like himself, to a by-gone age, and who had witnessed many remarkable events and social changes, it cannot be doubted that Dr Lee must have derived from this acquaintance a great deal of traditional knowledge as to the civil and ecclesiastical history of Scotland in the eighteenth century, and his natural bias may have been confirmed towards that historical research, and that interest in personal character and anecdote, by which he was afterwards distinguished. Dr Carlyle, at his death in 1805, appointed Dr Lee one of his trustees, and committed specially to his care an autobiographical memoir, which cannot fail to be full of interest, and as to which, I may be permitted to express a hope, that it will ere long be communicated to the public.

Among other eminent clergymen who befriended Dr Lee in the outset of his career, special mention ought also to be made of Dr Finlayson, of whom he always spoke in terms of the warmest regard, and to whose memory he has dedicated one of the painted windows now put up in the Old Greyfriars' Church.

About the same early period, Dr Lee came to be for some time connected with the late Sir John Lowther Johnstone of Westerhall, in the capacity of tutor or guardian, and was thus brought into contact with several eminent public men, with whom Sir John was on familiar terms. I have heard that Sir John made to Dr Lee two offers, either of which, if accepted, would have materially altered his future course in life. One was, to bring him into Parliament for one of Sir John's burghs; the other, to procure him a commission in the Guards. These offers, if made, were certainly declined; but he retained his ward's friendship and respect, and, from his gratitude, derived, during life, a pension of L.100 a year, which Sir John settled on him.

After taking his medical degree, he seems to have entertained some idea of following medicine as a profession; and he has been heard to say, that at one time, when a young man, he had three medical appointments in his possession or power; one, as assistant surgeon to a regiment; another, as surgeon's mate on board a ship; and a third, as a surgeon in the East India Company's Service. Finally he rejected all thoughts of the medical profession, and fixed upon the Church as the field to which he should dedicate his life.

In 1807 Dr Lee became minister of a Scotch Chapel in London, and, in the same year, he was presented to the parish of Peebles. He continued there till 1812, when he became Professor of Church History in St Mary's College, St Andrews, where he remained till 1821. A portion of the lectures he then delivered, embracing the History of the Church of Scotland from the Reformation, is now announced for publication, and cannot fail to excite a lively and general interest.

In 1820, before quitting his chair at St Andrews, he was appointed Professor of Moral Philosophy in King's College, Aberdeen, where he lectured for one session, chiefly by a deputy, to whom he transmitted his lectures daily by post. He speedily resigned his chair at Aberdeen, and in 1821 was removed to the charge of the parish of Canongate, Edinburgh; and thereafter, he successively held the other charges of Lady Yester's Church, and the Old Church Parish, in this city.

In 1824 he was named one of the Royal Commissioners for visiting the Scotch Universities. In 1827 he became Principal Clerk of the General Assembly. In 1837 he was appointed Principal of the United College of St Andrews, but did not long retain the appointment. In 1838 he was offered, but declined, the appointment of Secretary to the Bible Board, then newly constituted.

In 1840 he was elected Principal, and in 1843 he was appointed Professor of Divinity, in the University of Edinburgh. Previously, during the session of 1827–28, he had taught gratuitously the Divinity class, and afterwards, during the session of 1851–52, he taught gratuitously, again, the Moral Philosophy class, and in 1853–54, the Church History class, in the College of Edinburgh, during vacancies in those chairs occasioned by the death or the illness of their Professors.

He held the appointments of Chaplain to the Queen, of Dean of the Chapel Royal, of Chaplain to the Royal Academy, and to the Convention of Royal Boroughs, and he was at his death one of the Vice-Presidents of this Society.

I have ventured to say that he was one of the most learned men of his time, and in some departments of National and Church History, particularly in all that concerns the civil and ecclesiastical affairs, as well as the manners and habits of the people of Scotland, during the sixteenth and seventeenth centuries, his knowledge was most minute and accurate. He was also at home in the cognate subject of the History of the Puritans during the same period. We have lately witnessed in this city the exposure to sale of a portion of his library, consisting of upwards of 20,000 volumes, some of them of the most rare and curious description; and I believe that there was not one of his books with which he was not familiar, and of which he did not know, as well as it could be known, the authorship, the occasion, the object, and the import. The subject of Bibliography had been from his early years a favourite study; and his habits of assiduity and perseverance, as well as his capacious and retentive memory, enabled him to prosecute it with singular success. Nor was his intellectual power overlaid or paralysed by the immense mass of his acquired knowledge. His opinions on all subjects, and particularly on those to which he had directed his special attention, were clear and comprehensive; while, at the same time, they were marked by that candour and moderation, which I believe to be universally produced by the thorough and accurate study of any branch of knowledge or portion of history.

As in the case of many men of learning and talent, his published works are but an imperfect indication of his actual powers. Principal Lee, however, has left some things behind him, such as the "Memorial for the Bible Societies," and the "Pastoral Addresses" composed by him for the General Assembly, which show at once the force of his understanding, the variety and accuracy of his information, the rectitude of his feelings, and the purity of his taste. His stores of learning also were always at the service of those who wished to make use of them, and his ready aid has been repeatedly acknowledged as having given additional value to some of the most important works of our time on ecclesiastical or antiquarian subjects. I would fain hope that, among his numerous papers, much may yet be found that deserves and demands publication.

Dr Lee's health had never been robust, and was probably injured in early life by habits of abstinence and excessive study. But it was wonderful with what energy and vigour he discharged his duties and followed out his favourite pursuits. He died on 2d May 1859, in the 80th year of his age, and in circumstances which had a melancholy connection with the death of a dear son just returning from India.

No man could be more universally regretted; he had not an enemy or an ill-wisher in the world. The numerous appointments which he successively and simultaneously held are a proof of the esteem and respect with which he was regarded by all; but those only who knew him well can speak to his amiable disposition, to his cheerful and genial habits, and to the charity and Christian kindness which he extended to all men of worth and merit, of whatever opinions or whatever persuasion. An account of Dr Lee, indeed, would be very inadequate if it did not prominently bring forward what I have thus alluded to—his highly amiable and affectionate character. In early life he earned on all sides the love as well as the respect of those who knew him. In his ministerial charge at Peebles, he was long remembered for his quiet and unostentatious, but most faithful discharge of his pastoral duties, for his ready and hearty sympathy with all who needed it, for his consolatory tenderness to the sick, and his great liberality to the poor. Nor were these qualities of the heart extinguished or impaired by the long life of labour and study which he afterwards led; on the contrary, they continued to the end. He was ever ready to relax into a playful cheerfulness and pleasantry in society; while his attention to such of his friends as from sorrow or suffering had more serious claims upon him was unremitting and invaluable.

In consequence, perhaps, of some defect of manner, Dr Lee was not sought after as an attractive preacher. But his sermons were excellent, both in matter and in style, and some of his earlier ones, when read in manuscript, had reached and obtained the approbation of Royalty itself. In other respects he was all that a minister of the gospel ought to be. Orthodox in doctrine, evangelical in sentiment, and blameless in conduct, he had a frankness and freedom from professional pedantry or clerical rigour which are rarely met with in men of his learning and condition. We shall not soon see his like again, if we ever do so in our day. Piety, zeal, eloquence, and assiduity will not be wanting to the Church; but the combination of these with the learning, the wide range of information and sympathy, and the knowledge of the world which he possessed, will not readily be found again.

The next name I have to record among those who have been taken from us, is that of William Pulteney Alison, who was also, at his death, a Vice-President of the Society. Dr Alison was the eldest son of a most amiable and excellent man, the Rev. Archibald Alison, long an Episcopal minister in this city, well known for his elegant published sermons, and for his Essay on Taste, in which he explained with much success his views of the influence of association in producing or heightening the sense of beauty, a theory which, within moderate limits, is founded on truth, but which has been brought into discredit by the extravagant length to which it was unfortunately carried in Lord Jeffrey's dissertations on the same subject.

Dr Alison in early life had the advantage of the best society which Edinburgh could boast of, and of which his father was a cherished and distinguished ornament. His education and connections led him to bestow much attention upon the subject of mental philosophy, which he cultivated with great success. Bnt he ultimately adopted medicine as his profession, to which he was probably drawn by the example and influence of his distinguished relative the late Dr James Gregory, and in which he was destined to find an appropriate career for his talents, acquirements, and virtues.

It would be idle in me to detail or dilate upon the particulars of his professional life, which was in all respects eminently successful, and in the course of which he came to hold a high place both as a teacher of medical science and as a practising physician. The notice of him which has lately appeared in the "Medical Journal" is so full and complete as to leave nothing to be desired in this respect; and if I were to attempt to abridge it, I should only weaken its effect, and probably fall into errors from which no unprofessional man can easily keep free. Neither can it be necessary to inform any one here present of the valuable contributions which Dr Alison made to the theory of medicine, or of the great skill, the indefatigable patience, and the unfailing benevolence by which, as a physician, he was uniformly distinguished. His published works are generally regarded as entitling him to a high place as an expounder of the philosophy of medicine, and his powers as an oral teacher were peculiarly efficient, and exercised a marked influence on the progress of medical science. The time, the strength, and the resources which he bestowed upon the sick poor were almost incredible, and such as no one could have given who to vigour of bodily frame had not added the impulse of the warmest benevolence and the highest principle. As a practical philanthropist, his name deserves to be placed not far behind that of Howard himself.

It would be a serious omission in any notice of this excellent man if his views and exertions, with reference to the Poor Laws of the country, were not in some degree commemorated. Two theories upon that subject, diametrically opposed to each other, were at one time advocated by two distinguished men in Scotland—Dr Chalmers and Dr Alison. Chalmers, misled, I think, by the enthusiasm of his own genius, and overlooking the peculiar powers which he himself possessed, conceived the romantic idea, that a compulsory or legal provision for the poor might be altogether dispensed with. He maintained, that even the great towns, if they were duly subdivided and furnished with a certain amount of religious machinery and superintendence, might be so purified and elevated in the scale of moral and physical wellbeing, that any pauperism which they might still produce could easily be relieved by the voluntary bounty of Christian benevolence. For this purpose he made the rather startling demand, that at least twenty new parishes and churches should be established in Glasgow. He was gratified to the extent of having one new church erected and assigned to him for the trial of his great experiment; and it is possible that by his own unwearied diligence and unrivalled influence, together with the auxiliary exertions of another most remarkable man, Edward Irving, who was given him as his assistant, the pauperism of his district may have been kept within manageable bounds, and sufficiently relieved by the spontaneous offerings of the wealthier parishioners. But it was obviously impossible that any such system could be established over the whole country; and even if such machinery had been provided, nothing short of a miracle could have supplied men like Chalmers and Irving in every district to carry out the plan. At the commencement of the attempt, doubts were raised by judicious thinkers as to its probable success; and subsequent reflection and experience soon converted those doubts into certainties, and produced a general conviction that the scheme was Utopian.

The views of Dr Alison on this important subject were essentially different. Indulging in no chimerical anticipations, better suited to a prophetical millennium than to the everyday state of actual things, he looked earnestly to the evils that were immediately operating or impending, and sought anxiously to remedy or avert them. He maintained that a compulsory contribution for the poor was indispensable. It was the only way of interesting the selfish portion of the rich in the welfare of their poorer brethren, by inducing them to take measures for diminishing pauperism, so as to save themselves from taxation. He contended that the relief of destitution could not be safely left to the precarious care of voluntary charity, but should at all hazards be provided for so as to keep up the general tone of society, and save it from moral and physical evils of the first magnitude. Destitution, he conceived, when without regular relief, tended to lower the standard of subsistence among the poor to an alarming degree, and to make them forget that there was any better state of things which it was worth their while as Christians, or as human beings, to aspire to. Destitution, he further asserted, and his assertion seemed to be proved by his medical experience, was one of the most fertile sources of disease, and particularly of disease of an epidemic character. It was at once, particularly in great towns, a predisposing cause to every form of pestilence; and by depressing vitality, it interposed the greatest obstacles to a cure. He thus endeavoured to demonstrate that the administration of adequate relief to paupers was indispensable for the public good, and a necessary measure of sanitary precaution.

These principles were, over a series of years, reiterated by Dr Alison, and pressed upon the public attention with all the fervour of deep conviction and ardent benevolence; and they were seconded within our own locality by the occurrence of alarming epidemics, which could not fail to rivet the public attention on the subject. If it is not presumptuous to say so, we seem to have reason to infer that the infectious nature of certain diseases is designed by Providence to quicken our interest in our fellow-creatures, and to remind us that our own welfare depends, in a great degree, on the health and happiness of our neighbours. As a conflagration in an adjoining house makes us tremble for our own safety, so the prevalence of fever or pestilence in the poorer classes of our own city excites in us the fearful anticipation that the mischief may soon extend to us or to our children. It was the object of Dr Alison to prove (and I think he succeeded in proving), that if we wish to avert epidemic and infectious diseases from our own doors, we must attend to the physical as well as moral condition of our fellow-citizens, and must establish a certain and sufficient provision for the poor.

The theoretical opinions of Dr Alison would probably have led him to exact a legal provision even for the able-bodied poor, but subject always to the condition that no one should receive support who was not ready to work. The practical question, however, scarcely extended to this point; and the result of the discussion finally was, that the views of Dr Alison obtained a triumph over those of an opposite tendency. The Poor Law Act of 1845 was passed; and a system of Poor Law relief was thereby established, which, I venture to say, deserves the highest commendation, and is fraught with signal benefits to the social condition of Scotland. The Scotch Poor Laws had always recognised a legal right to relief in the impotent poor; but, in practice, the frugality or parsimony of the national character had led to great abuses, by restricting the allowances made to paupers to such miserable pittances as were scarcely sufficient to sustain life; while the courts of law had but an imperfect jurisdiction to redress the evil. By the new law, a remedy is provided in the Board of Supervision, which practically has the power of seeing that adequate allowances are given to paupers by the local boards.

The Scotch Poor Laws had denied relief to the able-bodied poor; and it cannot be doubted that this question is one of a most delicate kind, as the right of the able-bodied poor to demand support might, if pushed to an extreme, lead to little less than a community of goods. The new Act still disallows any legal right in the able-bodied, but permits parochial boards to give them occasional relief, as a precautionary measure; and it is thought that this middle course effects a prudent compromise of the dispute.

The blessings, direct and indirect, which are likely to flow from this improved system of the Poor Laws, and from the increased attention thus given to the condition of the poor, may, in a great degree, be ascribed to Dr Alison's exertions; and his country owes to him, in this way, a debt of gratitude which even now it is difficult to estimate. The misery of the poor was alleviated, the tendencies to disease were diminished, the bonds of society were strengthened, and all were taught the important lesson that their own safety and happiness were indissolubly linked with those of other men.

It is curious to compare the early dawn and promise of Dr Alison's life with the character of its ultimate progress and development. The tastes and pursuits of his accomplished father were chiefly those that belonged to a man of elegant and pious contemplation. His own youthful aspirations are said to have tended towards a military life. The employments of his maturer years were certainly of a very different kind, though bearing still a strange moral analogy to these influences. He became engaged in a warfare, but it was with social misery and maladministration, and he carried it on in the pure and self-denying spirit of that great Exemplar who came into the world to heal our diseases and bear our infirmities, and who went about continually doing good. In the words of a distinguished friend, who knew him and loved him well, "it is not too much to say, that Scotland will mourn in him for one of the best of the Christian sons who have adorned her soil;—one who devoted himself, body and soul, to what he believed to be the good of his fellow-creatures, with a wisdom that looked beyond the present, with an energy that cast away all thought of self, with a Christian love that never failed."

The latter days of Dr Alison's life were clouded by the visitation of severe and distressing disease. With conscientious firmness, he resigned his professorial position, and retired into private life. To the last, however, he enjoyed intervals of serene and useful exemption from his sufferings; and it was only last year that he contributed to the Transactions of this Society an interesting notice of his cousin, the late Dr William Gregory. But the fatal ailment was making sure progress in his system, and terminated fatally on 23d September 1859, when he had attained his 70th year.

Another eminent and excellent member of this Society who has been taken from us is the late Lord Cathcart, for many years well known as Lord Greenock, his father having survived till the year 1843. A great part of Lord Cathcart's career belongs to professional or public life, and is fitter for the military or historical annals of the country than for the journals of a scientific society. His military services and distinctions, however, are proper here to be generally noticed, as illustrating, and making more conspicuous, the devotion to science which he eminently showed.

Lord Cathcart was born in the year 1785, and entered the army at the age of fifteen. His choice of a profession was the result of no aversion to classical studies, to which he was uniformly attached, nor of any vulgar ambition for the outward show of the military profession, but of a strong sense of public duty, which was indeed the guiding principle of a long and useful life. He was for several years afterwards actively employed in military service, until, for a short time, he was disabled by the injurious effects of that pestilence which, in the Walcheren expedition, cut off so many thousands of our countrymen. In 1810, when now a major in the army, he embarked for the Peninsula, anxious to follow the fortunes of his relative, Sir Thomas Graham, afterwards Lord Lynedoch, then second in command in that field. He distinguished himself in several of the most important battles and sieges in Spain, until he was sent to assist Lord Lynedoch in Holland, as the head of the Quarter-Master-General's Staff, on which occasion the Duke of Wellington took leave of him in these words:—"I am convinced that Sir Thomas will be as glad to receive your assistance as we are sorry to lose it." He was afterwards present at Waterloo, where he greatly distinguished himself, and where he had three horses shot under him. For his services during the war he received the Russian Order of St Waldemir, and the Dutch Order of Willems, and at home he was made a Companion of the Bath.

During subsequent years he was appointed to employments of the highest importance at home and abroad, and it may be interesting to mention that his mind was first turned to the study of Geology while in the command of the Royal Staff Corps stationed at Hythe, in Kent. The corps was a scientific one, and had formed a museum of the various objects collected by its several detachments; and in this way Lord Cathcart was led to take an interest in a subject to which he ever afterwards devoted much of his attention. In 1830 he came to live in Edinburgh, and for some years was occupied by scientific pursuits. He attended lectures in the University; he took an active concern in the proceedings of the Highland Society; and of the Royal Society he was an assiduous and useful member, having read several papers which are published in its Transactions. In 1841 he discovered a new mineral—a sulphuret of cadmium—which was found in the course of excavating the Bishopton Tunnel, near Port Glasgow, and which received after him the name of Greenockite. If his quick eye had not there detected it, it would probably have remained unknown, as it has not (I believe) been discovered elsewhere. It is a beautiful substance, that was entirely new to mineralogists.

In 1837 Lord Cathcart had been appointed to the command of the forces in Scotland. In 1842 he was made a Lieutenant-General, and in 1845 he was sent out as Commander of the Forces in British North America. He held this appointment for several years in very difficult times, and for some period combined with it the civil government of Canada. In 1849 he returned home, but still continued to give the public the benefit of his services in various capacities. Latterly, he resided at his seat in Sussex, where he passed the last years of his life in a happy retirement, surrounded by his family, and finding an interesting occupation in the scientific pursuits which he had always loved so much.

In 1858 his constitution gave way, and on the 16th July 1859 he died peacefully, in the full possession of his faculties to the last. He was a man of powerful mind, which was improved by great industry and perseverance; and he had a kindly and generous heart, which threw a sunshine around the circle of his domestic life.

To those who had not the pleasure of his acquaintance, it is not easy to give a correct impression of what Lord Cathcart was to the Royal Society, and the scientific men of Edinburgh, from fifteen to twenty-five years ago.

Under an exterior and with an address which did not adequately represent the qualities concealed behind them, he had a warmth of heart, a sterling modesty, a steadiness of purpose, and a love of science for its own sake, which are seldom combined in the same person. He was very retiring in his habits and conversation. Few could have imagined that he had gone through the amount of service detailed in the preceding narrative; and if it be considered how total a revolution of habits and employments was involved in the transition from his military to his civil life, it is remarkable what success and energy attended his scientific career during the years he spent among us. He was distinguished by persevering and acute observation in what regarded geological and mineralogical research, which he carried on in a minute, laborious, and systematic manner. He detected many interesting phenomena in the very neighbourhood of Edinburgh, which had escaped those who had lived there always. His conversation on these subjects was pre-eminently instructive; and it is believed that he never took an ordinary walk without bringing home some specimen, or at least some remembered fact, which served him for subsequent meditation. He was fond of the society of men of science, and his continued interest in the Royal Society formed an essential element in its prosperity.

Lord Murray, at one time a Vice-President of the Society, is another member whose loss we have to lament, in common with all who knew him, and in common, I may add, with very many whom he never knew. Though not specially devoted to science, he took a warm interest in its progress, and was himself an ardent and discriminating lover of literature, and an accomplished scholar. His high social as well as official position—his connection by relationship or friendship with many of the foremost men and families in the country—his cordial hospitality and polished manners—and, joined to these, the still higher qualities of large liberality of sentiment, great moral courage, and Christian philanthropy and beneficence—gained him the love and esteem of his friends and fellow-citizens, and made his loss be felt, even at his advanced years, as a public bereavement, and as a personal affliction to all who had felt or witnessed the influence of his character.

We have also lost in this year the last of a most distinguished family of medical teachers, Dr Alexander Monro of Craiglockart, for many years Professor of Anatomy in the University of Edinburgh. He was in his 86th year when he died, having been born on the 25th of November 1773. He was the son of Alexander Monro the second, who again was the son of a distinguished father of the same name—all three being Professors in this University. The late Dr Monro was appointed assistant and successor to his father in 1798; and after his father's death, he occupied the chair with great reputation and success until 1845, when he resigned it, having, during that long period, numbered among his pupils many who became the most eminent physicians and surgeons of our day in both ends of the island. Dr Monro was an active member of the medical and literary societies of Edinburgh; and at the time of his death he was the Father of the Royal Society. The Papers which he contributed, as well as his other published works, are highly creditable to his talent and industry. His character, in every way indeed, though latterly less known from his advanced years and retired mode of life, was deserving of the high respect which it always received; and he ought especially to be remembered as one of those whose cultivated tastes in departments beyond the range of his profession contributed to secure for the society of Edinburgh the reputation which it has so long maintained, and which others, it is to be hoped, will take care that it does not now lose. Dr Monro's death seemed to sever the last tie which united the present generation to one long passed away, but ever illustrious and memorable as containing the founders of that great medical school among us, which still flourishes in undiminished splendour, and which, I trust, is not soon destined to decay.

Alexander James Adie, optician in Edinburgh, is another valued member of the Society whom we have lost. He was born at Edinburgh in 1775; and from the early death of his father, was thrown upon the care of a maternal uncle, Mr John Miller, optician in Edinburgh, a well-informed and kind-hearted old man, fond of books and philosophy, and a great friend of one to whom Scotland is under considerable obligations, Mr David Herd, a well-known editor of Scottish ballads. Under his uncle's instructions, Mr Adie became an optician, and followed his profession with great diligence and assiduity; while, from a sense of his imperfect education in youth, he was not ashamed as he grew up to attend lectures, and take lessons at his leisure hours in all branches of science in which he found himself deficient.

His attention to business, with his skill as a mechanic, his quick inventive powers, and his sound judgment, led to his being much employed by all kinds of inventors, to give their schemes a practical form; and in this way he acquired great readiness and experience in the higher parts of his profession. His attention was at the same time directed at an early period to meteorological observations, with a view to which, and also with reference to the study of astronomy, he erected on his house in Merchant Court a small private observatory, long before any public establishment of the kind existed in Edinburgh. To his experiments the public are indebted for the important invention of the sympiesometer, an instrument of great value at sea, and which may be considered as having contributed much to the safety of shipping. Mr Adie took great interest and gave valuable assistance in the preparation of apparatus and instruments required by scientific men in the course of their discoveries. He assisted Sir James Hall in his experiments for illustrating geological formations under high pressure, and his ingenuity was of great service in the construction of the minute but powerful lenses of garnet to which Sir David Brewster resorted in his improvements of the microscope.

In such operations, in the daily conduct of his business, and in the education of his family, he spent the active part of a long life. In his later years he was an assiduous and successful gardener, and carried on experiments in that art till a late period. At the age of eighty-four he died as quietly as he had lived, respected and revered by all his family and acquaintance. I ought to mention, that in his youth he was a keen Volunteer, and always maintained that no invader could ever have got to Edinburgh except over the dead bodies of the Volunteers. I have no doubt he would have felt an equal interest, and an equal confidence, in the volunteer movement of the present day.

While these pages were in preparation, we were deprived of another eminent and valuable member of the Society in Professor George Wilson, who has been suddenly carried off in the prime of life.

Dr Wilson was born in Edinburgh in the year 1818, and was thus, at his death, in the 41st year of his age. His parents were highly respectable, though not in such an elevated station as to diminish the credit due to his own exertions in attaining the position which he ultimately reached; but it deserves to be noticed, that he may be included in the number of distinguished men who have been in a great degree indebted for the development of their talents to the maternal character and influence. Dr Wilson's mother, a lady of remarkable intelligence, energy, and piety, is still living, to cherish the memory of his love to her, and of his many virtues and high reputation.

He was educated at the High School, where he always maintained a good place in his class. He entered the University of Edinburgh in or about the year 1834, and took his medical degree in 1839. In the interval, his attention came to be more specially directed to the chemical department of medical science, and he was successively engaged as chemical assistant to Dr Christison and to Professor Graham of London.

In 1840 he began to lecture in Edinburgh on chemistry in connection with the extra Academical Medical School. But at this time his health received a severe shock from the effects of excessive exertion during a pedestrian tour, which rendered amputation of the foot necessary, and ultimately led to a delicacy of constitution which settled upon his lungs.

He continued to teach as a private lecturer for upwards of fifteen years, and during that period secured the admiration, respect, and love of all who came in contact with him. His pursuit of knowledge was extensive and indefatigable, and his power of exposition was marked by the greatest clearness and animation, such as never failed to awaken in his hearers the strongest interest in the subject he was treating. He all along continued to cultivate a wide range of general literature, and his elegance of taste and reach of illustration were of much service in adding to the attraction of his prelections, as well as giving a great charm to his conversation, and to his literary productions. His published works and contributions to periodical literature are too well known to require detailed notice. Those which related to scientific subjects were distinguished by a minuteness of research and a precision of statement which give them a very great value, and which could hardly have been expected in one who was able at the same time to embellish them with so many beauties derived from his ample stores of imagination and fancy. His "Treatise on Colour Blindness" is a remarkable example of the exhaustive and practical manner in which he could treat such a subject; and his Lives of Scientific Men, while laudably compressed into a narrow compass, as compared with most modern biographies, are pregnant with valuable information and important results. He was in every way admirably qualified to diffuse among a wide circle of hearers and readers a strong interest in science as intimately connected with art and ordinary life.

In the spring of 1855 he was appointed Director of the Industrial Museum, a situation for which he was eminently suited; and in the autumn of the same year he was appointed to the Chair of Technology, then recently founded in the University of Edinburgh, in connection with the Museum. It is needless to say in this meeting with what ability and success he discharged these duties. It was fondly hoped that in this congenial position, in the midst of friends and fellow-citizens who loved and appreciated him, and in the bosom of his own affectionate family, his constitution might gain strength, and that he might live to develop more fully, and perhaps in some new and original shape, the talents and genius of which he was possessed. But such was not the destiny appointed for him. He was sometimes, perhaps, too careless of consequences, where the call of supposed duty was heard, or where an opening of usefulness was afforded; and in the middle of much ill health, and many warnings of danger, he continued to exert himself in a manner that would have been more appropriate in one of robuster frame. But his pleasure lay in the exercise of his intellectual faculties, in the advancement of science, and in availing himself of every opportunity to do good or show kindness; and it is probable that the pious resignation with which he long contemplated his precarious condition, and the state of preparation which he constantly endeavoured to maintain against the approach of death, may have led him to fear that event less, and to despise precautions for his own safety which his friends would have wished him to adopt. I need not say that his talents and merits, as a man of science and literature, were equalled by the amiableness of his disposition, and by his moral and religious excellencies. He won, and he preserved, the friendship of some of the most eminent men of his time; and no one who came within the sphere of his influence could resist its attraction. The honours that he attained, and the success that attended him in life, were not considered by others to be more than he well deserved: but he himself was humble and unassuming; thankful for the mercies that he considered he had received, and, in the midst of much bodily suffering and distress, not merely patient and submissive, but cheerful and happy. His last illness was only a severer form of many previous attacks: but he had continued to labour to the last; and in particular his duties at the meeting of the British Association at Aberdeen, in the autumn of this year, were discharged by him under great debility, such as probably tended to unfit him for the severity of the winter that was at hand. The disease of the lungs having assumed a serious aspect, made rapid progress, and his death ensued on the 22d of November 1859. His end was calm and peaceful, such as became the pious, innocent, and useful life which he had led, and left his friends no cause to mourn, except for the loss which they themselves sustained.

The unusual number of deceased members in the past year, as well as the eminence in their various departments of those whom I have now specially noticed, must furnish my apology, first, for the imperfect nature of the preceding sketches, and, next, for my forbearing to attempt any similar account of the other members of whom we have been deprived. Some of these need no eulogy from any one, while there are others on whose worth and value it would have been a pleasing task to expatiate, if time and the pressure of other claims had permitted it. I must therefore content myself with the simple enumeration of their names.

No. of Fellows for	1858,	. . . .	262
Do. do.	1859,	. . . .	256

Of the Fellows of Session 1858–59, there have died 13:—

Alex. Adie, Esq.
Dr W. P. Alison.
Right Hon. Earl Cathcart.
Dr Gillespie.
Dr Mortimer Glover.
Right Hon. Earl of Haddington.
John Learmonth, Esq. of Dean.
Very Rev. Principal Lee.
Professor Low.
Right Hon. Earl of Minto.
Dr Monro.
Hon. Lord Murray.
Sir James Ramsay, Bart.

Died since the printing of this year's list, 3:—

Dr James Andrew.
Hon. Mountstuart Elphinstone.
Dr George Wilson.

We have also lost the following Honorary Members, all of them men of the most distinguished eminence:—

Baron Humboldt.
Mr Hallam.
Mr Robert Stephenson.

The Fellows elected during Session 1858–59, are 10:—

Dr John Brown.
Rev. John Duns.
Dr Fayrer.
G. W. Hay, Esq.
Lieut. John Hills.
Dr Lyon Playfair, C.B.
Prof. Richardson, Durham.
George Robertson, Esq., C.E.
Robt. Russell, Esq.
Wm. F. Skene, Esq.

All of whom have been cheerfully welcomed among us; while some of them, I feel assured, will consent to take an active part in our proceedings, and lend their personal influence, as well as their names, to maintain the reputation and usefulness of the Society.

I now proceed to advert to some of the business proceedings of the Society which deserve attention. During the past year the Council have awarded two of the medals and prizes with which they are entrusted.

I. The medal and prize founded by the liberality of our venerable President Sir Thomas M. Brisbane, was in the first instance proposed by the Council to be given for a biographical notice of a Scotchman eminent in science. No satisfactory replies having been received to the programme of the Council, they were unwilling to delay much longer the application of the fund destined by the founder for the reward of scientific labour. They considered it would be creditable to the Society, and in conformity with the wishes of Sir Thomas Brisbane, to take the opportunity of the Meeting of the British Association in Aberdeen, to confer this honorary distinction on Sir Roderick Murchison (who was present at the meeting), in consideration of his original, persevering, and successful exertions to throw light upon the super-position and real age of vast geological formations of extreme antiquity in the north-western Highlands. The medal was, by permission of the British Association, presented to Sir Roderick Murchison by Sir David Brewster our Senior Vice-President, at one of the evening meetings at Aberdeen.

II. The NEILL MEDAL and Prize, founded by our late member Dr Patrick Neill, for the encouragement of the natural history studies in which he took a life-long interest, has been awarded by the Council to Dr Lauder Lindsay, a Scotchman, but not a fellow of this Society, for a paper on the Lichens, showing immense labour and research. This paper has been submitted to competent botanists for their opinion, and the Council have pleasure in stating that it has received their high approbation. It will therefore not merely be rewarded by the Neill Medal and Prize, but it is in the course of being printed at length in the Transactions, and of being illustrated by numerous plates, beautifully executed by the well-known artist, Mr Tuffen West of London. The delay which Fellows of the Society have experienced in receiving their fasciculus of transactions arises from the wish of the Council to include in it this important contribution, which will very soon be completed.

A change in the arrangement of the Society's apartments, which the Council hope will be universally considered to be an improvement, has (after many delays) been carried into effect during the past summer.

While formally entering with the Board of Manufactures into an extension of the lease of the Society's present premises, the Council very readily agreed to exchange the Old Museum upstairs for an apartment of the very same size on the ground-floor, immediately to the south of the present suite, with which it is made to communicate by opening a new door. The increased convenience of this for our conversational evening meetings must be plain to every one, and will, we hope, be experienced this evening, when the New Museum will be opened for the first time.

It may be added, that though some outlay has been incurred in connection with this improvement (as well as for the cleaning and decoration of the old rooms) no additional rent will be paid by the Society.

It may also be mentioned that the Museum has been transferred to its new place of deposit, under the charge of the Curator, with the assistance of some other members of the Society, after distributing among several public bodies some isolated specimens formerly contained in it, which were of little value to us, and which will be of more use to science when forming a part of other collections. The Society's collection in Geology and Mineralogy has been fully preserved, and is very valuable and useful.

Mr Swan, who was one of our Secretaries, has, to the regret of the Council, resigned his office in consequence of being appointed to the Chair of Natural Philosophy in St Andrews. But the Society has been so fortunate as to secure in his place the services of Dr Lyon Playfair.

Mr Carruthers, the Sub-Librarian, having removed to London, Mr John Livingston has been appointed his successor; and the Council have every reason to hope that his services will give satisfaction to the Fellows of the Society.

Lord Neaves then delivered the Neill Medal, which had been awarded to Dr Lauder Lindsay, for his Paper on the Spermogones and Pycnides of Lichens.

The following Candidate was elected an Ordinary Fellow:—

Captain Gordon Forlong, Bengal Engineers.

The following Donations to the Library were announced:—

The United States Naval Astronomical Expedition to the Southern Hemisphere. 1849–52. Vol. III. 4to.—*From the U. S. Government.*

Army Meteorological Register for 1826–30, and for 1831–42. 8vo.—*From the same.*

Statistical Reports of the Sickness and Mortality in the Army of the United States, from January 1819 to January 1839. 8vo.—*From the same.*

Maury's Wind and Current Charts. Gales in the Atlantic. 4to. —*From the same.*

Observations on the Physical Geography and Geology of the Coast of California. By W. E. Blake. 4to.—*From the same.*

Report of the Commissioner of Patents for 1856. Arts and Manufactures, 3 vols.; Agriculture, 1 vol. 8vo.—*From the same.*

Report of the Superintendent of the Coast Survey, showing the Progress of the Survey during 1856. 4to.—*From the same.*

Army Meteorological Register, from 1843 to 1854. 4to.—*From the same.*

Statistical Reports of the Sickness and Mortality in U. S. Army, from January 1839 to January 1855.—*From the same.*

Geological Survey of Missouri. First and Second Annual Reports. By G. C. Swallow. 8vo.—*From the Missouri Legislature.*

Report (Eleventh) of the Board of Agriculture of the State of Ohio, for 1856. 8vo.—*From the Ohio State Board of Agriculture.*

Tables, Meteorological and Physical, prepared for the Smithsonian Institution. By A. Guyot. 8vo.—*From the Institution.*

Proceedings of the American Association for the Advancement of Science. Vols. X. and XI. 8vo.—*From the Association.*

Meteorology in its connection with Agriculture. By Prof. Joseph Henry. 8vo.—*From the Author.*

Transactions of the Academy of Science of St Louis. Vol. I., Part II. 8vo. *From the Academy.*

Proceedings of the American Philosophical Society. Vol. VI., Nos. 57 and 58. 8vo.—*From the Society.*

Proceedings of the American Academy of Arts and Sciences. Vol. III., Nos. 32–52; Vol. IV., No. 1. 8vo.—*From the Academy.*

Catalogue of North American Mammals, chiefly contained in the Museum of the Smithsonian Institution. By Spencer F. Baird. 4to.—*From the Institution.*

Map of Chicago Harbour and Bar.—*From Lieut.-Colonel J. D. Graham.*

The Canadian Journal. Nos. 20 and 21. 8vo.—*From the Canadian Institute.*

Journal of the Proceedings of the Linnæan Society. Supplement to Botany. No. 2. 8vo.—*From the Society.*

Temperature of the Sea around the Coasts of Scotland during 1857–58. By James Stark, M.D. 8vo.—*From the Author.*

Catalogue of the Admiralty Library. 8vo.—*From the Admiralty.*

Memoirs of the Geological Survey of India. Vol. I., Part II. 8vo. —*From the Governor-General.*

Recherches Experimentales sur les Effets du Courant Electrique appliqué au Nerf Grand-sympathetique. Par MM. Philippe Comte Linati et Prince Caggiati. 8vo.—*From the Authors.*

Report of the Teneriffe Astronomical Experiment of 1856. Addressed to the Lords Commissioners of the Admiralty. By Professor C. P. Smyth. 4to.—*From the Lords Commissioners.*

A Treatise on Problems of Maxima and Minima, solved by Algebra. By Ramchudra; edited by Aug. De Morgan. 8vo.—*From the Secretary of State for India.*

Monatsbericht der Koniglichen Preuss. Akad. der Wissenschaften zu Berlin. July to Dec. 1858. 8vo.—*From the Academy.*

Uëbersicht der Witterung im nördlichen Deutschland nach den Beobachtungen des Meteorologischen Instituts zu Berlin. 1855, 1856, 1857, and 1858. 4to.—*From the Institute.*

Quarterly Journal of the Chemical Society. No. 45. 8vo.—*From the Society.*

Philosophical Transactions of the Royal Society of London. Vol. CXLVII., Part III., 1857; Vol. CXLVIII., Parts I. and II., 1858. 4to.—*From the Royal Society.*

Astronomical, Magnetical, and Meteorological Observations, made at the Royal Observatory, Greenwich, in the year 1857. 4to. 1859.—*From the same.*

Report of the Joint Committee of the Royal Society and the British Association, for procuring a Continuance of the Magnetic and Meteorological Observations. 8vo.—*From the same.*

Atti dell' I. R. Istituto Lombardo di Scienze, Lettere ed Arti. Vol. I., Fasc. X. ed XI. Folio.—*From the Institute.*

Memorie dell' I. R. Istituto Lombardo di Scienze, Lettere ed Arti. Vol. VII., Fasc. V., VI., VII., ed VIII. Folio.—*From the same.*

Monumenta Sæcularia der Kön. Bayer. Akademie der Wissenschaften, 28 März 1859. 4to.—*From the Academy.*

Rede bei der Hundertjæhrigen Stiftungsfeier der Kön. Bayer. Akademie der Wissenschaften, Am 28 März 1859. Gehalten von G. L. von Maurer. 4to.—*From the same.*

Rede zur Vorfeier des Geburtsfestes Seiner Majestät des Königs Maximilian II. Gehalten von Geheim-Rath Fr. v. Thiersch. 4to.—*From the same.*

Erinnerung an Mitglieder der Math:-physik. Classe der Kön. Bayer. Akademie der Wissenschaften. Von Dr C. F. Ph. von Martius. 4to.—*From the same.*

Almanach der Kön. Bayer. Akademie der Wissenschaften für das Jahre 1859. 32mo.—*From the same.*

The Atlantis: A Register of Literature and Science, conducted by Members of the Catholic University of Ireland. No. 4. July 1859. 8vo.—*From the University.*

Journal of the Royal Dublin Society. July 1859. 8vo.—*From the Society.*

Proceedings of the Royal Geographical Society of London. Vol. III., No. 4. 8vo.—*From the Society.*

Transactions of the Royal Scottish Society of Arts. Vol. V., Part II. 8vo.—*From the Society.*

Mittheilungen der Naturforschenden Gesellschaft in Bern. 1856–57. 8vo.—*From the Society.*

Verhandlungen der allgemeinen schweizerischen Gesellschaft für die gesammten Naturwissenschaften. Aug. 1857. 8vo.—*From the Society.*

Neue Denkschriften der allgemeinen schweizerischen Gesellschaft fur die gesammten Naturwissenschaften. Band XVI. 4to. —*From the same.*

The Quarterly Journal of the Geological Society. Vol. XV., Part III. 8vo.—*From the Society.*

Die Fortschritte der Physik in Jahre 1856. Dargestellt von der Physikalischen Gesellschaft zu Berlin. 8vo.—*From the Society.*

Transactions of the Royal Society of Literature. Vol. VI., Part II. 8vo.—*From the Society.*

Proceedings of the Royal Medical and Chirurgical Society of London. Vol. III., No. 2. 8vo.—*From the Society.*

Report of the Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire. 1858–59. 8vo.—*From the Society.*

Annual Report of the Leeds Philosophical and Literary Society. 1858–59. 8vo.—*From the Society.*

Proceedings of the Royal Geographical Society. Vol. III., No. 5. 8vo.—*From the Society.*

The Canadian Journal. July 1859. 8vo.—*From the Editors.*

The Quarterly Journal of the Chemical Society. No. 46.

Proceedings of the Horticultural Society of London. Nos. 1 to 3. 8vo.—*From the Society.*

Quarterly Return of the Births, Deaths, and Marriages. No. 18. 8vo.—*From the Registrar-General.*

Smithsonian Report for 1857. 8vo.—*From the Smithsonian Institution.*

Smithsonian Contributions to Knowledge. Vol. X. 4to.—*From the same Institution.*

Reply to the "Statement of the Trustees" of the Dudley Observatory. By B. A. Gould, jun. 8vo. 1859.—*From the Author.*

Defence of Dr Gould. By the Scientific Council of the Dudley Observatory. 8vo.—*From the Council.*

Paper and Resolutions in Advocacy of a Uniform System of Meteorological Observations throughout the American Continent. By Major R. Lachlan. 8vo.—*From the Author.*

Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences. T. XLIX., Nos. 4–5. 4to.—*From the Academy.*

Report of the British Association for the Advancement of Science. Leeds, 1858. 8vo.—*From the Association.*

On the Chemical Composition of the Granites of Ireland. By Professor Haughton. 8vo.—*From the Author.*

Experimental Researches on the Granites of Ireland. By Professor Haughton. 8vo.—*From the Author.*

On the Lower Carboniferous Beds of the Peninsula of Hook, County Wexford. By Professor Haughton. 8vo.—*From the Author.*

On the Evidence afforded by Fossil Plants as to the Boundary-Line between the Devonian and Carboniferous Rocks. By Professor Haughton. 8vo.—*From the Author.*

On the Black Mica of the Granite of Leinster and Donegal. By Professor Haughton. 8vo.—*From the Author.*

Notes to Accompany Figures of some Distorted Fossils from Cleaved Rocks of the South of Ireland. By Professor Haughton. 8vo.—*From the Author.*

On Serpentines and Soapstones. By Professor Haughton. 8vo.—*From the Author.*

On some Rocks and Minerals from Central India. By Professor Haughton. 8vo.—*From the Author.*

Journal of the Geological Society of Dublin. Vol. I., Parts II.–IV.; Vol. II., Parts I.–III.; Vol. III., Parts I.–IV.; Vol. IV., Parts I.–II. 8vo.—*From the Society.*

Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences. Nos. 6 and 7. 4to.—*From the Academy.*

Notes as to the Construction of Breakwaters for Harbours of Refuge. By D. & T. Stevenson. 8vo.—*From the Authors.*

Supplement to Daubeny's "Descriptions of Volcanoes." 8vo.—*From the Author.*

Silliman's American Journal of Science and Arts. Vol. XXVIII., No. 82. 8vo.—*From the Editors.*

Bulletin de la Société de Geographie. Tome XVII. 4me Sèr. 8vo.—*From the Society.*

An Account of the Life, Lectures, and Writings of William Cullen, M.D. By Drs John and William Thomson and Dr Craigie. 2 vols. Edinburgh, 1859. 8vo.—*From Dr Allen Thomson and Dr Craigie.*

Monthly Return of Births, Deaths, and Marriages. August 1859. —*From the Registrar-General.*

Proceedings of the Royal Society of London. Vol. X., No. 36. 8vo.—*From the Society.*

Uber die Hügel bei Sitten im Wallis. By Professor Studer. 4to. —*From the Author.*

Journal of Proceedings of the Linnæan Society. Vol. IV., No. 14. 8vo.—*From the Society.*

Memoires de l'Académie Royale des Sciences de Belgique. Tome XXXI. Bruxelles, 1859. 4to.—*From the Academy.*

Memoires Couronnés et Memoires des Savants étrangers publiés par l'Académie Royale de Belgique. Tome XXIX. Bruxelles, 1859. 4to.—*From the Academy.*

Annales de l'Observatoire Royale de Bruxelles; par A. Quetelet. Bruxelles, 1859. 4to.—*From the Observatory.*

Observations des Phénomènes periodiques.—*From M. Ad. Quetelet.*

Memoires Couronnés et autres Memoires publiés par l'Académie Royale de Belgique. Tome VIII. Bruxelles, 1859. 8vo.—*From the Academy.*

Bulletins de l'Académie Royale de Belgique. 2me Sèr. Tomes IV.-VI. Bruxelles, 1859. 8vo.—*From the Academy.*

Annuaire de l'Académie Royale de Belgique, 1859. Bruxelles, 1859. 12mo.—*From the Editor.*

Annuaire de l'Observatoire Royale de Bruxelles; par Ad. Quetelet. Bruxelles, 1858. 12mo.—*From the Editor.*

Tables générales et analytiques du Recueil des Bulletins de l'Académie Royale de Belgique. 1re Sér. Tome I.-XXII. 8vo.

Sur les travaux de l'ancienne Académie de Bruxelles. Discours par A. Quetelet. 8vo.—*From the Author.*

Observations des Passages de la Lune et des Étoiles de même culmination; par Ad. Quetelet. 8vo.—*From the Author.*

Sur le Magnetisme terrestre; par M. Hansteen. Lettres adressées a M. A. Quetelet. 8vo.

Sur la Comète de Donati, visible à l'œil nu; par M. Ad. Quetelet. 8vo.—*From the Author.*

Sur la Constance dans le nombre des mariages et sur la statistique morale en générale; par M. Ad. Quetelet. 8vo.—*From the Author.*

Rymbybel van Jacob van Maerlaut. Bruxelles, 1859. 8vo.

Transactions of the Architectural Institute of Scotland (Session 1857–58). Edinburgh, 1859. 8vo.—*From the Institute.*

Magnetische Untersuchungen in Nord-Deutschland, Belgien, Holland, Dänemark. Von J. Lamont. Munich, 1859. 4to.—*From the Royal Observatory of Munich.*

Proceedings of the Royal Astronomical Society. 8vo (Monthly).—*From the Society.*

Journal of the Society of Arts (Weekly). 8vo.—*From the Society.*

Jahres-Bericht der Münchener Sternwarte für 1858. Munich, 1859. 8vo.—*From the Royal Observatory of Munich.*

Monatliche und jährliche Resultate der an der Königlichen Sternwarte bei München von 1825 bis 1856 Angestellten Meteorologischen Beobachtungen.—*From the Royal Observatory of Munich.*

Atti dell I. R. Istituto Lombardo di Scienze, Lettere ed Arti. Vol. I., Fasc. 1–9. Milan, 1858.—*From the Institute.*

Memorie dell' I. R. Istituto Lombardo di Scienze, Lettere ed Arti. Vol. VII., Fasc. 1–4.—*From the Institute.*

Memoires presentées par divers Savants à l'Académie des Sciences de l'Institute Impériale de France. Vol. XV. Paris, 1858. 4to.—*From the Academy.*

Journal of Agriculture and Transactions of the Highland and Agricultural Society of Scotland. No. 66 (New Series). Edinburgh. 8vo.—*From the Society.*

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften (Mathematisch Naturwissenschaftliche Classe). 1858. Parts I.–XV. Bände XXIV., XXV. 1, 2; XXVI., XXVII. 1.

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften (Philosophisch-Historische Classe). Bände XXIII. 5; XXIV. 1, 2; XXV. 1, 2, 3; XXVI. 1, 2; XXVII.—*From the Imperial Academy.*

Almanach der Kaiserlichen Akademie der Wissenschaften. Vienna, 1858. 8vo.—*From the Academy.*

Festrede bei der Feierlichen Übernahme des ehemaligen Universitätsgebäudes vom Dr T. G. von Karajan. Vienna. 8vo.—*From the Academy.*

Die Principien der heutigen Physik von Dr Andreas Ritter v. Ettingshausen. Vienna. 8vo.—*From the Academy.*

Jahrbücher der K. K. Central-Anstalt für Meteorologie und Erdmagnetismus. Von Karl Kreil. Band V. Vienna, 1858. 4to.

Denkschriften der Kaiserlichen Akademie der Wissenschaften. Band XIV. Vienna. 4to.—*From the Academy.*

Memoirs of the Royal Astronomical Society. Vol. XXVII. London, 1859. 4to.—*From the Society.*

Monthly Notices of the Royal Astronomical Society. Vol. XVIII. London, 1858. 8vo.—*From the Society.*

Brockhaus (H.) Die Sage von Nala u. Damaganti.—*From the Royal Saxon Society.*

Berichte d. Philolog. Histor. Classe, 1858. II.—*From the same Society.*

Fechner psychophysisches Grundgesetz.—*From the same Society.*

Hankel elehtrische Untersuchungen. No. 4.—*From the same Society.*

Hofmeister Phanerogamen.—*From the same Society.*

Berichte d. Math. Phys. Classe. 1858. II. and III.—*From the same Society.*

Bulletin de la Société Palæontologique de Belgique. Tome I., Parts I.–IV.—*From the Society.*

Proceedings of Literary and Philosophical Society of Liverpool. 1858–59.—*From the Society.*

Proceedings of Horticultural Society of London. Nos. 4–6.—*From the Society.*

Registrar-General's Monthly Report (September).—*From the Registrar-General.*

Quarterly Journal of Chemical Society.—*From the Society.*

Notices of Proceedings of Royal Institution of Great Britain.—*From the Institution.*

Proceedings of Royal Institution of Great Britain. Part IX. 1859.—*From the Institution.*

Journal of Royal Geographical Society. 1858.—*From the Society.*

Transactions of Zoological Society. Vol. IV., Part VI.—*From the Society.*

Proceedings of Zoological Society. Part XXVI., 1858; Parts I. and II., 1859.

Notice of Royal Astronomical Society. No. 10.—*From the Society.*

Annual Report of Royal Cornwall Polytechnic Society. 1858.—*From the Society.*

Bulletin de la Société Imperiale de Moscow. Nos. 23 and 24. 1858–59.—*From the Imperial Society.*

Registrar-General's Monthly Report (October).—*From the Registrar-General.*

Reply to Sir David Brewster's Memorial to the Lords Commissioners. By D. and T. Stevenson.—*From the Authors.*

Journal of Royal Dublin Society (October 1859).—*From the Society.*

Proceedings of Royal Geographical Society. No. 6.—*From the Society.*

Admiralty Charts.—*From the Admiralty.*

Six Plans of the Rise and Fall of the River Indus. 1845–48.—*From the Indian Government.*

Series of Military and other Maps. By Colonel Jervis.—*From W. P. Jervis,* Esq.

Bulletin de la Société Vaudoise.—*From the Society.*

Places of 5345 Stars observed from 1828–54 at the Armagh Observatory. By Rev. T. R. Robinson, D.D.—*From Her Majesty's Government.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. IV. 1859–60. No. 51.

Monday, 19*th December* 1859.

DAVID MILNE HOME, Esq., in the Chair.

The following Communications were read:—

1. Note on some Numerical Relations between the Specific Gravities of the Diamond, Graphite, and Charcoal Forms of Carbon and its Atomic Weight. By Dr Lyon Playfair, C.B., F.R.S.

Recent researches have shown that there is an intimate relation between the specific gravities and atomic weights or equivalents of solid and liquid bodies. This relation is not so simple as that which prevails in regard to the volumes and combining numbers of gaseous bodies, and yet it is sufficiently marked to indicate many important chemical analogies. The formula for eliciting these relations is—

$$\frac{E}{d} = V,$$

in which E is the equivalent, *d* the specific gravities, and V the atomic volume.

It is to be borne in mind, that the unities or starting-points for specific gravities and for atomic weights are essentially distinct. In the first case, the weights of the bodies are compared with the weight of an equal bulk of water; in the second instance, the combining numbers refer to a unit weight of hydrogen. Nevertheless, the relations observed between the specific gravities and the atomic weights are well marked in bodies of a like character.

It has always been considered interesting to examine these relations in regard to Carbon, which has three well-characterised allotropic forms. The atomic volumes obtained by the above formula show no satisfactory relations between the numbers obtained for each of the states in which the element presents itself.

Before we examine them in another way, it is desirable to obtain a mean specific gravity for the Diamond, Graphite, and Charcoal, as the recorded results of experiment show a considerable variation.

1. *Diamond.*

The specific gravity of this gem is generally stated in elementary works to range from 3·5 to 3·55; but these numbers do not represent the mean of recorded experiments, as will be seen by the following table:—

Diamond in Hunterian Museum, Glasgow,	3·53	Thomson.[1]
Specific gravity, as stated by Mohs, .	3·52	Mohs.[2]
Brazilian diamond, . . .	3·44	Brisson.[3]
Another variety of the same, . .	3·52	
Mean specific gravity of a "beautiful collection of diamonds," . . .	3·48	Lowry.[4]
"Star of the south," . . .	3·53	Dufrenoy & Halphin.[5]
Borneo diamond, . . .	3·49	Grailich.[6]
Do. do., compact, . .	3·41	Rivot.[7]
Do. do., do., . .	3·25	

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[1] Thomson's Mineralogy, vol. i. p. 46.

[2] Mohs' Mineralogy, vol. ii. p. 306.

[3] Brisson, as quoted by Böttger, Specifiche Geiwicht., p. 32.

[4] Lowry, as quoted by Thomson's Mineralogy, vol. i. p. 46.

[5] Dufrenoy, Compte Rendu, vol. xl. p. 3.

[6] Grailich Bull. Geol. [2], vol. xiii. p. 542.

[7] Rivot, Ann. des Mines, vol. xiv. p. 423.

Diamond used in Jacquelain's experiments,	3·33	Jacquelain.[1]
Specific gravity, as given by Henry, .	3·55	Henry.[2]
Well-crystallized Brazilian diamond, weighing 0·5761 gramme in the Edinburgh Museum, . . .	3·48	Playfair.[3]
Mean sp. gr.,	3·461	

If we reject the second Borneo diamond of Rivot, which has too low a specific gravity, we have a mean sp. gr. of 3·48, which is the same number as that found by Wilson Lowry for the mean specific gravity of "his beautiful collection of crystallized diamonds" (Thomson's Mineralogy, vol. i. p. 46).

It is to be expected that the experimental determination of the specific gravity of diamonds should be rather above than below the truth; for we are aware that they all leave a minute quantity of ash on burning, and that this ash, according to Petzhold, contains silica and iron.

2. *Graphite.*

This variety of carbon is often impure, being not unfrequently contaminated with upwards of five per cent. of earthy impurities. Recorded specific gravities upon such impure specimens are of no value for the mean result as regards pure graphite. The following determinations are all those which I can find upon specimens which have been chemically examined to establish their purity :—

Natural graphite, . .	2·27	Regnault.[4]
Do. . .	2·25	Schrader.[5]
Do. . .	2·32	
Graphite of iron furnaces, .	2·33	Karsten.[6]
Natural graphite, in fine crystalline plates,	2·14	Breikhaupt.[6]
Do. do., another variety,	2·22	
Do. do., do.,	2·23	Kengott.[7]

[1] Jacquelain, Ann. de Ch. et Thys, [2], vol. xx. p. 459.

[2] Henry's Mineralogy, vol. iv. p. 19.

[3] Experiment made for this paper.

[4] Regnault, Ann. de Ch. et Thys., vol. lvi. p. 37.

[5] Schrader, Annals of Philosophy, vol. i. p. 299.

[6] As quoted in Böttger's Specifiche Gewicht.

[7] Kengott, Wien Akad. vol. xiii. p. 469.

Natural graphite,	2·50	Pelouze and Fremy.[1]
Gas carbon graphite,	2·35	Graham.
Mean sp. gr.,	2·29	

It would have been interesting to have added to this list a determination of the specific gravity of Brodies' purified Ceylon graphite; but its minute division causes the air to adhere to it so tenaciously, that I have failed in getting any correct determinations of its density.

3. *Charcoal.*

There are comparatively few determinations of the specific gravity of pure charcoal. It is in fact not so easy to obtain this substance. A specimen of charcoal from pure sugar, repeatedly calcined, and treated with chlorine to remove the last traces of hydrogen, and again calcined, gave me the sp. gr. 1·80; but bubbles of air still adhered to it, although it was kept for several hours under a good air-pump. The following determinations are those recorded:—

Pure lamp-black,	1·78	Baudrimont.[2]
Fibrous gas coke,	1·76	Colquhoun.[3]
Compact gas carbon,	2·08	Baudrimont.[4]
Powdered coke (mean),	1·80	Regnault.[5]
Charcoal from alcohol,	2·10	Scholtz.[6]
Charcoal from sugar,	1·80	Playfair.[7]
Pure charcoal, without pores,	1·84	Griffith.[6]
Mean sp. gr.,	1·88	

4. From the preceding data we take the mean specific gravity of the three varieties of carbon to be as follows:—

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[1] Traite de Chimie, vol. v. p. 518.

[2] Baudrimont, Traite de Chimie, vol. i. p. 511.

[3] Colquhoun's Annals of Philosophy [2], vol. xii. p. 1.

[4] Baudrimont, Traite de Chimie, vol. i. p. 514.

[5] Regnault, Traite de Chimie, vol. i. p. 369.

[6] Böttger Specifiche Gewicht.

[7] Experiment recorded above.

	Mean Sp. Gr.
Diamond, . . .	3·48 or 3·461.
Graphite, . . .	2·29
Charcoal, . . .	1·88

5. We have now to consider whether these numbers stand in any simple relation to their atomic weight. The formula

$$\frac{E}{d} = V$$

gives the following atomic volumes, taking Ꞓ = 12.

	Atomic Volumes.
Diamond, ...	3·44.
Graphite, ...	5·24.
Charcoal, ...	6·38.

These numbers do not bear to each other any simple relation.

6. If we now take the atomic weight of carbon (Ꞓ = 12), and then extract from it its square, cube, and fourth roots, numbers are obtained which bear a striking approximation to the mean specific gravity of the three forms of carbon:—

	Roots.	Sp. Gr.
1 -	$\sqrt[2]{12} = 3{\cdot}464$	- Diamond, 3·48 or 3·46.
2 -	$\sqrt[3]{12} = 2{\cdot}289$	- Graphite, 2·29.
3 -	$\sqrt[4]{12} = 1{\cdot}865$	- Charcoal, 1·88.

In other words, if we raise the specific gravity of diamond to its second power, that of graphite to its third power, and that of charcoal to its fourth power, we obtain numbers closely approaching in each case to 12, the atomic weight of carbon.

Diamond, . . .	$3{\cdot}48^2 = 12{\cdot}11.$
Graphite, . . .	$2{\cdot}29^3 = 12{\cdot}00.$
Charcoal, . . .	$1{\cdot}88^4 = 12{\cdot}49.$

These approximations are remarkable, and the relations of the numbers are natural and simple. The differences between the mean experimental numbers and the corresponding roots of the atomic weight of carbon are not so great as the differences observed in the specific gravities of the same form of carbon.

7. It may be useful to condense into the form of a table the previous observations:—

Forms of Carbon.	Experiment.		Calculations.	
	Sp. Gr.	Powers.	Ȼ	Roots.
Diamond,......	3·46 or $3{\cdot}48^2$	= 12·11	$\sqrt[2]{12}$	= 3·464
Graphite,......	$2{\cdot}29^3$	= 12·00	$\sqrt[3]{12}$	= 2·289
Charcoal, ...	$1{\cdot}88^4$	= 12·49	$\sqrt[4]{12}$	= 1·865

These relations appear to be so simple, that it is scarcely possible to conceive that they may not have been described before; but I have been unable to find such descriptions. The nearest approach to it which I know, is the fact that Mr Hawksley, the engineer, stated to me, many years since, that he had brought under the attention of the late Mr Cooper the relation which seemed to subsist between the specific gravities of silver and gold and their atomic weights, this being approximatively the square root of their atomic weights, or of multiples of these numbers. But I cannot find any record either of Mr Hawksley's or Mr Cooper's views on the subject.

8. We know two other bodies besides carbon which possess diamond, graphite, and amorphous forms—viz., Silicon and Boron. If the same relation were observed between the specific gravities and atomic weights of these bodies, it would go far to establish as a law what, in an isolated case, might be due to a remarkable combination of chances. Unfortunately, we know only the specific gravity of the diamond forms of these elements:—

Silicon diamond,	. .	2·49	Deville.
Do.,	mean on six specimens,	2·48	Playfair.

In quoting these results some explanation is necessary. In the original memoirs of Deville, it is left uncertain whether he examined the specific gravity of diamond or graphite silicon; and manuals of chemistry give it as the result due to the latter form; but from its coincidence with my own experiments on diamond silicon, it must unquestionably refer to that variety. Among the six specimens examined by myself, one preparation was in peculiarly fine crystals, and gave the sp. gr. 2·46; two out of the six specimens were prepared by Dr

Matthiesien, and gave a mean sp. gr. of 2·47. The remainder were inferior samples, and probably contained zinc and other impurities.

Professor Miller has kindly examined for me the specific gravity of a good specimen of graphite silicon in his possession (not analyzed), and found it to be 2·337.

Deville gives as the specific gravity of boron diamond 2·68.

The crystalline form of the boron diamond is the same as that of the carbon diamond, and similar relations seem to exist between the specific gravity and atomic weights. The atomic weight of boron is 7·2, viewing its oxide as corresponding to carbonic acid in composition.

$$\sqrt[2]{7{\cdot}2}=2{\cdot}683. \qquad \text{sp. gr.}=2{\cdot}68.$$

But the same relation would not appear to hold for silicon, which does not affect the like tendency to crystallize in the same forms as carbon and boron, although the relations between the numbers in its case also are in the same direction, and not devoid of simplicity.

The atomic weight of silicon is 14·2.

$$\mathrm{Si}\ \sqrt[3]{14{\cdot}2}=2{\cdot}42 \qquad \text{sp. gr. of diamond silicon, } =2{\cdot}46 \text{ to } 2{\cdot}48.$$

$$\overline{\mathrm{Si}}\ \sqrt[4]{28{\cdot}4}=2{\cdot}30 \qquad \text{sp. gr. of graphite silicon, } =2{\cdot}33.$$

The differences exhibited in this case from the similar forms of Carbon and Boron are not sufficiently marked to throw doubt upon the relations as being due to some unexplained law. As an arithmetical probability, indeed, the discordance lessens the value of the testimony in the previous cases. But our chemical knowledge of the manner in which Silicon doubles and quadruples itself in the silicates, to unite with the same quantity of base, gives support to the idea that its atomic weights may be different in the various forms of the separate element.

When we consider how much we multiply the errors of experiment in raising the observed specific gravities to the second, third, and fourth powers, it remains scarcely possible that the simple relations between them and the atomic weights, in the cases which I have pointed out, can be due to chance. I have purposely avoided any speculation as to the bearing which these relations may have on the molecular arrangement of the particles of the elements in their various forms, as I desire, in the first place, to submit the testimony on which the relations themselves are founded to the consideration of chemists.

But it may be fairly asked, whether any similar relations exist between the specific gravities and atomic weights of the remaining solid or liquid non-metallic elements. I take the following mean specific gravity for bromine, iodine, sulphur, and selenium, and omit the only two remaining elements—phosphorus and tellurium—from the list, because they do not appear to yield relations at all analogous to those under consideration:—

Bromine, sp. gr., ...	2·966	Balard.
	2·980	Lowig.
	2·990	„
Mean, . .	2·979	

Iodine.—There is only one recorded specific gravity of this element—viz., that by Gay Lussac. I have estimated the specific gravity of two fine specimens in my laboratory, and take the mean of these results:—

	4·948	Gay Lussac.
	5·030	Playfair.
Mean, . .	4·989	

Sulphur, sp. gr., ... =2·0

Selenium, . .	4·30	Berzelius.
	4·32	„
	4·31	„
Mean, . .	4·31	

Tabulating these results, and bringing into comparison with them the roots of the atomic weights, we have the following striking accordances:—

	Sp. gr.	Equivt.	Roots.
Boron, . .	2·68	$\sqrt[2]{7{\cdot}2}$	= 2·68
Silicon . .	2·46	$\sqrt[3]{14{\cdot}2}$	= 2·42
Bromine, . .	2·98	$\sqrt[4]{80{\cdot}0}$	= 2·99
Iodine, . .	4·99	$\sqrt[3]{127{\cdot}0}$	= 5·02
Sulphur, . .	2·00	$\sqrt[4]{16{\cdot}0}$	= 2·00
Selenium, . .	4·31	Se$\sqrt[3]{80{\cdot}0}$	= 4·31

2. Some Miscellaneous Observations on the Tadpole, and on the Albumen of the Newly-laid Egg. By John Davy, M.D., F.R.S. Lond. and Edin.

On the Tadpole of the Frog.—The author *first* notices the jelly—the peculiar enveloping matter of the ova—describing its properties and uses,—the latter, according to him, for the double purpose of defending the eggs before being hatched, and affording the tadpoles food after their hatching. He considers the substance of the jelly a variety of albumen.

Secondly, He notices the ova, which he describes as resembling, in their properties and composition, those of fishes.

Thirdly, He enters into some details respecting the growth of the tadpole and its metamorphosis, specially dwelling on the fact, that whilst in the change to the advanced form there is a diminution of volume, there is an increase of solid matter—the young frog having a bony skeleton, which the tadpole is destitute of.

Fourthly, Experiments are given showing the effect of different degrees of temperature on the tadpole, and that of salt water of different degrees of saltness. From the last it would appear that even brackish water is fatal to them, thus limiting the habitat of the species; from the former, that a temperature exceeding 98° or 100° has the same effect; whilst one a little lower seems to promote a torpid state, such as the alligator is said to acquire during the season of tropical heat and drought.

On the Albumen of the Newly-laid Egg of the Common Fowl.—From the experiments described, it would appear that the albumen of the newly-laid egg differs from that of the egg kept for some time: 1st, In becoming milky at about 150° Fahr., owing to the formation of innumerable granules, so small as barely to be seen with the microscope,—a quality which may be preserved for a considerable time by the exclusion of oxygen, effected by lubricating the shell with oil or butter; 2dly, In forming, at a higher temperature, a softer coagulum.

3. On Acupressure, a New Method of Arresting Hæmorrhage.

By Professor Simpson.

Professor Simpson made a communication on acupressure, as a new mode of arresting surgical hæmorrhage. After describing the various methods of stanching hæmorrhage in surgical wounds and operations which the Greek, Roman, Arabic, and Mediæval surgeons employed, he gave a short history of the introduction of the ligature of arteries, and spoke of it as—with the occasional exception of torsion for the smallest arteries—the hæmostatic means almost universally employed in chirurgical practice at the present day. But he thought that surgery must advance forward a step farther than the ligature of arteries, particularly if surgeons expected—as seemed to be their unanimous desire—to close their operative wounds by the immediate union or primary adhesion of their sides or walls.

All the march of modern surgery has been in the direction of attempting to increase the chances of the union of surgical wounds by the first intention, by diminishing more and more the irritation derived from the presence and action of the ligatures supposed to be inevitably required for the arrestment of the hæmorrhage. By the new hæmostatic process of acupressure, Dr Simpson hopes to overcome in a great degree all those difficulties, as by it he expected to arrest the hæmorrhage attendant upon surgical wounds *without leaving permanently any foreign body whatever* in the wound itself. It was an attempt to bring bleeding wounds, in common surgery, to the condition of wounds in *plastic surgery*, where no arterial ligatures were used, and where union by the first intention was in consequence the rule, and not the exception to it.

Dr Simpson stated that he had tested, with perfect success, the effects of acupressure as a means of effectually closing arteries and stanching hæmorrhage, first upon the lower animals, and lately in two or three operations on the human subject. The instruments which he proposed should be used for the purpose were very sharp-pointed slender needles or pins of passive or non-oxidizable iron, headed with wax or glass, and in other respects also like the hare-lip needles commonly used by surgeons at the present day, but longer when circumstances required. They might be coated with silver or zinc on the surface, if such protection were deemed requisite.

That needles used for the purpose of acupressure, and passed freely through the walls and flaps of wounds, will not be attended by any great degree of disturbance or irritation, is rendered in the highest degree probable by all that we know of the tolerance of living animal tissues to the contact of metallic bodies. Long ago John Hunter pointed out that small-shot, needles, pins, &c., when passed into and imbedded in the living body, seldom or never produced any inflammatory action, or none at least beyond the stage of adhesive inflammation, even when lodged for years. Some time ago, when the subject of acupuncture specially attracted the attention of medical men, Cloquet, Pelletan, Pouillet, and others, showed that the passage and retention of long acupuncture needles was attended with little or no irritation in the implicated living tissues. The reviewer of their works and experiments in the *Edinburgh Medical Journal* for 1827 observes,—"It is a *remarkable* circumstance that the acupuncture needles never cause inflammation in their neighbourhood. If they are rudely handled or ruffled by the clothes of the patient, they may produce a little irritation; but if they are properly secured and protected, they may be left in the body for an *indefinite* length of time without causing any of the effects which usually arise on account of the presence of foreign bodies. In one of M. Cloquet's patients, they were left in the temples for eighteen days; and in cases in which needles have been swallowed, they have remained without causing inflammation for a much longer period. It appears probable, from the facts collected on the subject, that metallic bodies of every kind may remain imbedded in the animal tissues without being productive of injury." (Page 197.) All the late observations and experiments upon metallic sutures are confirmatory of the same great pathological law, of the tolerance of living tissues for the contact of metallic bodies imbedded within their substance. In the operation for hare-lip, where the whole success or failure of the operation depends on the establishment or not of union by the first intention, surgeons use needles to keep the lips of the wound approximated, often compressing these needles strongly with their figure-of-eight ligatures, and find this measure the most successful means which they can adopt for accomplishing primary adhesion.

The acupressure of arteries, when compared with the ligature of them, appears, as a means of arresting hæmorrhage, to present various important advantages:—

1st, Acupressure will be found more easy, simple, and expeditious in its application than the ligature.

2d, The needles in acupressure can scarcely be considered as foreign irritating bodies in the wound, and may always be entirely removed in two or three days, or as soon as the artery is considered closed; whilst the ligatures are truly foreign irritating bodies, and cannot be removed till they have ulcerated through the tied vessels.

3d, The ligature inevitably produces ulceration, suppuration, and gangrene at each arterial point at which it is applied; whilst the closure of arterial tubes by acupressure is not attended by any such severe and morbid consequences.

4th, The chances, therefore, of the union of wounds by the first intention should be much greater under the arrestment of surgical hæmorrhage by acupressure than by the ligature.

5th, Phlebitis, Pyæmia, &c., or, in other words, traumatic or surgical fever, seem not unfrequently to be excited by the unhealthy local suppurations and limited sloughings which are liable to be set up in wounds by the presence and irritation of the ligatures.

6th, Such dangerous and fatal complications are less likely to be excited by the employment of acupressure, seeing the presence of a metallic needle has no such tendency to create local suppurations and sloughs in the wound, such as occur in the seats of arterial ligatures.

And 7th, Hence, under the use of acupressure, we are entitled to expect both, *first*, that surgical wounds will heal more kindly and close more speedily; and, *secondly*, that surgical operations and injuries will be less frequently attended than at present by the disastrous effects and perils of surgical fever.

The following Donations to the Library were announced:—

Transactions of the Botanical Society of Edinburgh. Vol. VI., Part II. 8vo.—*From the Society.*

Monthly Notices of Astronomical Society. Vol. XX., No. 1. 8vo. —*From the Society.*

Proceedings of the Linnean Society. Vol. IV., No. 15. 8vo.—*From the Society.*

Canadian Journal. September and November 1859. 8vo.—*From the Publishers.*

Journal of Statistical Society. December 1859. 8vo.—*From the Society.*

Transactions of the Royal Medical and Chirurgical Society of London, 1859. 8vo.—*From the Society.*

Madras Journal of Literature and Science. April to September 1858. 8vo.—*From the Madras Literary Society.*

Transactions of Bombay Geographical Society. Vol. XIV. 8vo. —*From the Society.*

Aanteekeningen van het Verhandelde in de Sectie-Vergaderingen van het Provinciaal Utrechtsche Genootschap van Kunsten en Wetenschappen. 1855–1859. Utrecht. 8vo.—*From the Society.*

Verslag van het Verhandelde in de Algemeene Vergadering van het Provinciaal Utrechtsche Genootschap van Kunsten en Wetenschappen. 1856–59. 8vo.—*From the Society.*

Annales de l'Observatoire physique centrale de Russie. 1856. 4to.—*From the Observatory.*

Compte Rendu Annuel. 1857. 4to.—*From the Academy of Sciences.*

Report on Canadian Graptolites. By James Hall, Esq. Montreal, 1858. 8vo.—*From the Author.*

Tuesday, 3d January 1860.

PROFESSOR MORE in the Chair.

The following Communications were read:—

1. Some Miscellaneous Observations on the Growth of Birds, their Specific Gravity, and on the Stomach of Fishes in Relation to Digestion. By John Davy, M.D., F.R.S. Lond. and Edin.

On the Growth of Birds.—The author's observations on this subject are chiefly confined to the martin, the common fowl, the turkey, and goose. They all tend to show a rapid growth, varying in degree according to the habits of the species. The young martin was found on leaving its nest heavier than the parent bird; and this the growth, as to time, of about twenty days, reckoning from the hatching of the egg. A turkey poult, the day it quitted the egg, weighed one ounce and three quarters; in five months it had increased to ten pounds. A gosling, in thirty-four days, had increased in weight from six ounces to six pounds. A chick of the Dorking breed, in three months, had increased from an ounce and a half to three pounds. This rapidity of growth—a rapidity in the instance of nestlings fed by the parent birds essential to their existence—is referred to two principal causes, an active digestion and abundance of food, other circumstances aiding. The relation of the size of the egg of different species to that of the parent birds is suggested as an interesting subject for inquiry; and the conjecture is offered, illustrated by some examples, that the circumstances chiefly influencing that relation may be the manner in which the young birds are fed, whether by the old birds, or unaided by them, and the proportional abundance of food.

On the Specific Gravity of Birds.—The birds submitted to trial were the martin, the water-ouzel, snipe, wood-owl, merlin-hawk, and wren. These, deprived of their feathers, were found to be of nearly the same specific gravity as the water in which they were weighed. With the feathers on, in common with birds generally, they all floated in water, buoyed up by the lightness of their feathers,—these so light owing to the air they contain. As the air becomes disengaged on forced submersion, so the specific gravity of the bird increases. A wren, the specific gravity of which when first sunk in water was 0·890, after a continuance under water of twelve hours, had increased to 0·960. The specific gravity of the water-ouzel with its feathers on was found to be about 0·724; that of the merlin-hawk about 0·570. It is pointed out, in conclusion, how little the specific gravity of the bird is concerned as regards aptitude for aerial locomotion, and how it is subordinate to various circumstances, such as lightness from included air and a high temperature, and a great impulsive power of wing.

On the Stomach of Fish in relation to Digestion.—In the instances of the salmon and sea-trout, and indeed of all the fish tried—these including the common trout, charr, grayling, haddock, and dogfish—the stomach, when empty, was found by test-papers to be commonly neutral, and on the contrary acid when any food was present; leading to the conclusion that the gastric juice is secreted only when the organ is stimulated and that fluid is required. From observations on fish after death, kept for a certain time, sufficiently long for the fluids to act on the containing solids, denoted by softening and rupture, the inference is come to that the fluid of the appendices pyloricæ is most active in producing the post-mortem effects; and that the migratory species of the salmonidæ, the salmon and sea-trout, taking little food in fresh water, exhibit least this effect, and are least subject, from the emptiness of their primæ viæ, to putrefaction.

2. Notice of certain Remarkable Laws connected with the Oscillations of Flexible Pendulums: With Illustrative Experiments. By Edward Sang, Esq.

In a previous paper there had been given a general method of investigating the motions of elastic systems, when the redressing tendencies are proportional to the extents of the disturbance. The present paper contains the results of the application of this method to the oscillations of flexible pendulums, composed of weights attached by their centres of gravity to a thread. These results, though strictly applicable only to oscillations of infinitely small extent, may yet be held as indicating the general characters of oscillations of moderate dimensions.

The exceedingly complex motions of such a pendulum may always be resolved into as many simple oscillations as there are bodies in the system; a simple oscillation being such that, if it subsisted alone, all the moving points would pass through their mean positions at the same instant, and would also all reach the extreme limits of their motion at once.

The periodic times and the configurations of those simple motions can be computed by help of an equation rising to the degree indicated by the number of the bodies; and we obtain this very singular result, that "*Whatever may be the details of the system, the sum of the squares of these periodic times is equal to the square of the periodic time of a simple pendulum having the entire length of the flexible one;*" or, in other words, that "*If simple pendulums be constructed vibrating in accordance with the simple oscillations of such a flexible series, the sum of their lengths is equal to the whole length of the flexible line.*"

In order to cause any given pendulum to perform one of its simple oscillations, we would need to give to each one of its component parts a properly regulated impulse: thus we might compute their extreme positions; and, having placed each body properly, let them all go at the same instant. Hence it is a matter of great difficulty to exhibit a simple oscillation when the system consists of even so few as three or four parts.

When all the bodies are of one weight and uniformly distributed along the chord, the configuration of a simple oscillation is given by the formula—

$$x_n = x_A\left\{1 - \frac{n}{1}\left(\frac{l}{p}\right) + \frac{n}{1}\frac{n-1}{4}\left(\frac{l}{p}\right)^2 - \frac{n}{1}\frac{n-1}{4}\frac{n-2}{9}\left(\frac{l}{p}\right)^3 + \&c.\right\}$$

in which l is the length of one of the links, p that of a simple pendulum oscillating in the same time, x_A the ordinate of the lowest body A, and x_n that of a body situated n intervals above A.

When a flexible pendulum consists of two weights A and B, attached by their centres of gravity to two threads AB, BC of equal lengths, the ratio of the periodic times of its two simple oscillations may be exhibited by constructing a right-angled trigon PQX, such that the square of PQ may be proportional to the weight A, the square of QR to the weight B; this being done, the periodic time of the slower is to that of the quicker oscillation as QP + PR : QR.

The truth of this law was exhibited experimentally by making A nine and B sixteen ounces: an arrangement which gives the periodic times as 2 to 1; and also by making A sixteen and B nine, in which case the ratio is as 3 to 1.

When, by augmenting indefinitely the number of the weights, we pass from the discrete series to a continuous uniform flexible line, the previous equation takes the form

$$x = x_A\left\{1 - \frac{1}{1}\left(\frac{z}{p}\right) + \frac{1}{1}\frac{1}{4}\left(\frac{z}{p}\right)^2 - \frac{1}{1}\frac{1}{4}\frac{1}{9}\left(\frac{z}{p}\right)^3 + \&c.\right\}$$

in which p is the length of the corresponding simple pendulum, z the distance upwards from the lowest point A, and x_A the horizontal ordinate of A. These formula differ, the one from the well-known development of $\left(1-\frac{l}{p}\right)^n$, the other from $e^{-\frac{z}{p}}$ in having for the denominators of the successive co-efficient the squares of the natural numbers instead of those numbers themselves.

From this latter equation it follows, that if a uniform flexible chain could be made to perform one of its simple oscillations, its configuration would always have the character of the curve so indicated. Starting from the lowest point in a direction which, if continued, would cross the vertical axis at the height p, this curve crosses and re-crosses that axis, each wave being longer and flatter than the preceding: the first crossing is at the height $p \times 1{\cdot}445\,7965$; the second at $p \times 7{\cdot}617\,8156$; and the third at $p \times 18{\cdot}721\,7517$: hence the slowest oscillation of a uniform flexible chain of which l is the length accords with that of a single pendulum $l \times \cdot 691\,6603$ long: the second oscillation agrees with that of a simple pendulum having $l \times \cdot 131\,2712$ for its length, while the third oscillation corresponds to $l \times \cdot 053\,4138$.

The three oscillations of a chain were exhibited, and were shown to agree exactly with the computed times as well as with the figures which had been prepared.

In conclusion, it was remarked that, although these speculations be of interest chiefly to those whose attention is particularly turned to mechanical science, they are not devoid of attractions for the student of general physics, as they bear closely upon the received doctrines of acoustics, and also upon the undulatory theory of light. In these doctrines it is assumed, as the very foundation on which they are built, that the disturbance of an elastic medium engenders a series of waves which progress through that medium producing, in the case of air, the phenomenon of sound,—in the case of the supposed luminous ether, waves of light; yet a strict investigation shows that, when an elastic system is deranged at any one point, all the species of vibration of which the system is capable are at once called into existence, and that the isolation of one of the simple oscillations would require the simultaneous action of as many distinct and properly regulated impulses as there are particles in the system: in other words, it shows that the formation of the supposed aërial pulses, or of the imagined luminous waves, is physically impossible.

When we strike the string of a harp or of a clavichord, we do not cause it to perform its major vibration alone—on the contrary, we produce many of its partial motions also; and although the number of beats per second of its slowest oscillation be the principal argument of the theoretical musician, it by no means follows that those beats constitute more than an important element in what is truly the sound of the string.

The following Donations to the Society were received:—

Nautical Monographs. No. 1. 4to.—*From the Observatory, Washington.*

Silliman's American Journal. No. 84. Second Series. 1859. 8vo.—*From the Editors.*

Journal of Asiatic Society of Bengal. No. 3. 1859. 8vo.—*From the Society.*

Proceedings of the Academy of Natural Sciences of Philadelphia. 1859. 8vo.—*From the Academy.*

Extinct Vertebrata from the Judith River, and Great Lignite Formations of Nebraska. By Joseph Leidy, M.D. Philadelphia. 1859. 4to.—*From the Author.*

A Memoir on the Extinct Sloth Tribe of North America. By Joseph Leidy, M.D. 4to.—*From the Author.*

The Ancient Fauna of Nebraska. By Joseph Leidy, M.D. 4to.—*From the Author.*

Descriptions of some Remains of Fishes from the Carboniferous and Devonian Formations of the United States. By Joseph Leidy, M.D. Philadelphia. 1856. 4to.—*From the Author.*

Journal of the Academy of Natural Sciences of Philadelphia. 1859. 4to.—*From the Academy.*

Observations on the Genus Unio. By Isaac Lea, LL.D. Vol. VII., Part I. Philadelphia. 4to.—*From the Author.*

Lever's Year-Book and Railway and Mining Almanac. Manchester. 1860. 8vo.

Proceedings of Horticultural Society of London. No. 7. 1859. 8vo.—*From the Society.*

Monday, 16*th January* 1860.

LORD NEAVES, V.P., in the Chair.

The following Communications were read:—

1. Suggested Explanation of Messrs Carrington and Hodgson's recently observed Solar Phenomenon. By Professor C. Piazzi Smyth.

The Royal Society of Edinburgh having been the arena wherein Professor W. Thomson first described his calculations and admirable extensions of Mr Waterston's meteoro-dynamic theory of solar light and heat, I beg leave to call the attention of the same learned Society to an apparent instance of confirmation which that theory appears to me to have received, by a phenomenon of very unique character, recently observed in an independent and most satisfactory manner, by either of two able scientific men—viz., Mr Carrington of the Observatory, Red Hill, and Mr Hodgson at Highgate.

The respective observations of these gentlemen are to be found in the monthly notices of the Royal Astronomical Society for November 1859, and seem quite sufficient to prove, after making all due allowance for the different instrumental methods employed in either case, and the peculiar nature of the subject observed, that on September 1, at about 11 h. 18 m. A.M., Greenwich time, two small telescopic bodies of light, in close proximity, and elongated in the direction of their motion, suddenly burst into view on the surface of the sun, not very far from its central portion, than which they were very much brighter. They moved side by side in arcs nearly parallel with the plane of the ecliptic; first for a time increasing in brightness, and then again gradually fading away, so as to be quite lost in about five minutes after their first appearance. Though apparently on the surface of the sun, yet that appearance was considered to arise from optical projection only, as they did not alter the shape of a group of large black spots, which lay directly in their paths. They must, nevertheless, have been exceedingly close to the surface; and on that supposition, the paths which they described during their period of visibility must, from their angular extent, have measured about 35,000 miles, giving a mean rate of 117 miles per second.

The first remark that we may make on the facts of observation, save that nothing so momentary has ever been witnessed before by astronomers, is, that 117 miles per second constitutes a velocity so exceedingly great, that we can only look to the gravitation influences of the sun for its efficient producing cause. Nevertheless, we are at the same time bound to acknowledge, that the full rate of orbital motion, for a body nearly in contact with the surface of the sun, is rather over 276 miles per second; and the rate of falling to the sun from infinite space, considerably more. Evidently, then, something prevented these bodies of September 1 from moving at their full rate, and produced a retardation in their orbit equal to 159 miles a second, to take Professor W. Thomson's form of the gravitation theory as the more probable.

What that retarding something was, it is not so much to our purpose now to inquire, as long as we can show that it is not altogether a baseless supposition, to assume the existence of any extensive material belonging to the sun, outside his visible, luminous surface.

Now, this is fortunately easy of demonstration, for we have only to point to the red prominences, borders, and clouds, seen stretching to a distance of 60,000 miles sometimes from the edge of the solar orb during solar eclipses; or to those unmistakable evidences of a large amount of outer absorbent and obstructing atmosphere, indicated by the gradual yellowing and de-photographical properties of the sun's light, with every advance from the centre to the circumference of his disc. (See Teneriffe Report, "Philosophical Transactions" for 1858, p, 487.) Something material, therefore, and forming to all intents and purposes one body with the sun, does exist round about him; and capable, we cannot but allow, of affording impediment to the motion of any extraneous body, before it actually comes into contact with that intensely bright surface which is vulgarly held to constitute the outside of the sun.

Hence, when we find our solar meteors of September 1 moving at a rate slower by 159 miles a second than they should do according to the laws of gravitation, the simplest assumption that we can make is, that there has been a mechanical retardation to that amount. Let this be granted, and then it necessarily follows from the dynamical theory of heat, that precisely in accordance with the disappearance of motion will be the appearance of heat. And when we further take account of the previous high temperature to which the matter of the meteor (for the two, we are inclined to look on as fragments of one; unless Bielas' double comet is to be taken as an argument for constant double meteors also) was brought, during the long ages of its circulation around the sun, in an orbit whose mean distance decreased only secularly; and when we also consider the extraordinary warmth of the region where the observed rapid retardation took place, it will be understood that everything was extremely favourable to the heat produced by conversion of motion, appearing with so intense an expression, as to be accompanied by a most vivid display of light.

Even in the cold external atmosphere of the earth, and with a speed of only 19 miles in a second on the average to be converted, M. Joule has shown that meteors should become intensely white hot; and Professor Swan has described in the "Proceedings" of this Society, Vol. III., p. 220, a case of one bright enough to be conspicuously seen at noonday.

It is true that, according to Mr Waterston's form of the theory, and even the first expression of Professor W. Thomson's also, where the sun is fed by lumps of meteoric matter, there is some difficulty in explaining why the occurrence of luminous meteors in the sun is not frequently observed, if remarkably visible in one instance; while, according to the subsequent modification of the latter's view, the generality of meteors must be distilled away into impalpable clouds of finely-divided meteoric matter some time before they actually reach the sun; and neither gentleman had expected that an actual impact would ever be seen by mortal eye.

These objections, however, will be at once, to a great extent, relieved by the very fair assumption of as superior a mass to the September 1st meteor, over the generality of those which fall to the sun, in any and every manner, as men have already recorded of those which have actually fallen to, or have been seen very near, the earth; for while the majority (see the museums of Vienna, St Petersburg, and London) measure only a few inches, with occasional masses of 2 and 3 feet, there was one unusually well observed by many able spectators in Scotland, England, and France, on the 18th August 1783, which was estimated to be more than half a mile in length.

It may indeed be argued that, with this superior size of body, the decrease of the meteor's *radius-vector* in its orbit would have been slower than with smaller lumps revolving in the denser parts of the ethereal medium in the sun's immediate neighbourhood (see "Edinburgh Astronomical Observations," vol. xi. p. 266); and it would therefore have been exposed so much longer to the fiery heat of that region as to be distilled away, equally with the smaller ones, before actually touching the grosser parts of the solar atmosphere.

This argument, even carried to the extreme, does but remove the probability of the phenomenon of September 1st from being a meteor of the W. Thomson character, circulating around the sun, to one of Waterston's, falling to the sun from distant space; and while Professor W. Thomson has most satisfactorily demonstrated that, whatever may be the real character of the greater part of the solar light and heat, *some* of it must be due to meteoric action, so, while we freely concede to him that the majority of meteoric matter falling to the sun is of the planetary or satellite character, we are still entitled, according to his own reasoning on p. 67 of "Transactions of Royal Society of Edinburgh," vol. xxi. part i., as well as from some of the paths computed by M. Petit, of the Toulouse Observatory, to assume that some meteoric matter arrives from distant space, and falls nearly directly to the sun. In such case, the final rate of its motion being 390 miles per second, there would be small time for much more to be effected, than that that fused crust we so often find on terrestrial meteoric stones should be formed, prior to the commencement of rapid retardation, and before conversion of mechanical energy into heat; followed, doubtless, almost immediately by the breaking up of the matter from explosion and deflagration.

Let us inquire, then, how far the known meteoric mass of 18th August 1783 would suffice to produce the effects observed on September 1st, 1859, had it then fallen to the sun. Professor W. Thomson gives the amount of meteoric matter that would be required, according to Mr Waterston, to produce, by striking the sun, the average solar illumination, as 0·000060 lb. per square foot per second.

For the period of our phenomenon, or 5 minutes, this is ·018 lb. per square foot, and 501·811 lb. per square mile for the same time.

Now the meteor in question, said by Mr Cavalho to have had a diameter of 1070 yards, can hardly have contained less than 15,000,000,000 cubic feet; and if we take for its specific gravity a mean between what has been determined by many measures of earthy meteorites on one hand, and meteoric iron on the other (which comes extremely near the mean density of the earth), then the total weight must have been 5,250,000,000,000 lb. Whence it is evident that there was enough material in that one meteor, properly distributed, to keep a space 5,000,000 square miles of the sun's surface in a state of luminous ignition, twice as intense as that of the ordinary solar disc during all the time of observation; and therefore, by the transparency of flame, to have tripled the brightness of the parts passed over—a phenomenon which, from angular subtense, as well as intensity of light, would be abundantly visible to telescopic observation from our earth.

* To this we may further add another consideration, which would notably increase the quantity of light given out by the same meteor; for in the remarkable investigations which Professor W. Thomson has appended to his paper above quoted, relative to the

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* This paragraph added on January 16, 1860.

rotation and the age of the sun, he appears to have assumed, if I read him aright, that all the meteors in the solar neighbourhood are circulating in the same direction as the planets; and it is extremely probable that this is true for the greater number of them. Indeed, the publication in France, since this paper was placed in the hands of your Secretary, of the apparent discovery of a planet interior to Mercury, at considerably less than half his heliocentric distance, and revolving *direct*, might be taken as a remarkable proof of the correctness of the assumption. Nevertheless, we cannot close our eyes to the fact, that the members of the solar system which occasionally come visibly closest to the sun are not planets, but comets, and that, amongst these, retrograde motion is frequent; while of all comets, the one which has made the closest known approach, since the age of exact astronomy, was that of 1843, which was retrograde, and passed only 60,000 miles from the sun's surface. Hence it is by no means an unwarranted supposition for us to make, that an occasional meteor moves *retrograde* also; as, in fact, this one of September 1st appears to have done; and if it should, in such a course, encounter another moving *direct*, in the crowded solar vicinity—a casualty that must become more and more probable with every advance towards the sun—there would be double speeds of motion to be converted into heat; there would be much such a sudden blaze of light as the observers described; and then a rapid descent of both bodies to the sun's surface, through that remaining distance in which they might otherwise have long continued to circulate before their final absorption.

On the whole, then, it appears exceedingly probable that the solar phenomenon of September 1st was a meteor falling to the sun, and giving out the heat of its mechanical energy in accordance with the laws of that dynamical theory of thermotics, first and chiefly in this country brought before the Royal Society of Edinburgh by Professors W. Thomson and Macquorn Rankine. In which case, there is another example added, to several that might be extracted from the history of science, showing that hardly has a true theory been published to the world, before a confirmatory phenomenon, previously quite unexpected, is almost providentially witnessed; and in no case by less prejudiced or more able observers than the gentlemen upon whom we depend in the present instance.

2. On the Fallacy of the Present Mode of Estimating the Mean Temperature in England. By James Stark, M.D.

In the Meteorological Tables for England, published at the public expense, viz., those of Greenwich Observatory, and those of the fifty-five meteorological stations in England, appended to the Registrar-General's Quarterly Reports, the mean temperature as given is not the true mean, but is an estimated mean, deduced from the united observations made with the self-registering and dry-bulb thermometers, the exact means of these instruments being first altered by certain tables, with the view of correcting them for diurnal and monthly range. The author objected to this mode of estimating the mean temperature, because the tables used for the purpose of correction were drawn up from insufficient data, and because the principle was bad of having observations made by one instrument, whose readings were liable to constant errors, made the basis for the correction of observations made by a more trustworthy instrument.

The tables for the correction of diurnal range used in England were drawn up from a five years' series of observations; but by a reference to the Scottish observations, it was attempted to be shown that a five years' period was far too short to elicit even a true mean annual temperature ; while, by a reference to the mean temperature of corresponding months during five consecutive years, it was found that such a period gave still more incorrect results for the months.

It was then demonstrated, by a reference to the Greenwich monthly and daily observations, that the readings of the dry-bulb thermometer, at every two-hourly period, failed to give the true mean temperature either of the day or of the month, as they always missed the period of the day when the maximum temperature was attained, which, as indicated by the self-registering thermometer, was from 1° to 5° higher than any of the readings taken at the two-hourly periods. The consequence was, that the mean temperature deduced from the dry-bulb two-hourly readings was always *below* the truth, and it was impossible from them to ascertain at what period of the day the highest temperature was attained, so that the chief elements for the calculation of the amount of diurnal range were wanting.

The data, however, which were used for the formation of tables of correction for the self-registering thermometric observations were shown to be even more faulty than those used for that of the dry-bulb; *firstly*, from the circumstance that the faulty dry-bulb mean was held to be the only true mean, and made the basis for the correction of the self-registering mean; and *secondly*, from the circumstance that the whole of the self-registering observations were made with Six's registering thermometer, an instrument now considered inaccurate. By a reference to the Makerstoun Observations for a period of three years, and to those of Scotland for the last two years, it was demonstrated that, *when the self-registering thermometers are of proper construction*, the strict mean of the maximum and minimum readings appear to require no correction whatever, but indicate the true mean temperature. Particular attention was directed to the Makerstoun Observations for 1844, when hourly readings were taken with the dry-bulb thermometer, their strict mean giving the mean annual temperature as 44°9, while the strict mean of Rutherford's self-registering thermometer gave the annual temperature as 45°0, than which no results could be closer.

In the present state of the science, the author contended that the only safe rule for the estimation of mean temperature was to take the strict mean of the self-registering thermometers, provided these were of proper construction; and he strongly denounced the practice followed in England, of withholding the strict means of the different series of dry and wet bulb readings, and only publishing deductions, which the facts brought forward in his paper proved must, in most instances, be erroneous.

3. Description of the Plant which produces the Ordeal Bean of Calabar. By Professor Balfour.

After noticing the various plants used in Africa as ordeal poisons, the author gave an account of the introduction of the Calabar Ordeal Bean into Scotland, by the Rev. W. Waddell, and mentioned its peculiar poisonous qualities, as determined by Dr Christison. To Dr Hewan, and the Rev. Zerub Baillie, who are connected with the United Presbyterian Mission in Old Calabar, he was indebted for some observations on actual cases of poisoning in Africa. The Rev.

W. C. Thomson, another missionary, was the first who procured flowering specimens of the plant. Some of these had been given to the author by Mr Baillie, and from them, along with the legume and seeds, the characters of the plant had been drawn up. The plant belongs to the natural order Leguminosæ, sub-order Papilionaceæ, and tribe Phaseoleæ, and appears to be a new genus to which the name of *Physostigma* (φυσάω, to inflate) has been given, from the peculiar inflated appearance of the stigma. To the species the name of *venenosum* has been given, in allusion to its poisonous qualities. The genus is nearly allied to Phaseolus, from which it differs in the stigma, and in the long, grooved hilum of the seed. In the last character it approaches Mucuna.

Physostigma venenosum is a large twining plant, with a thick stem, and pinnately-trifoliolate leaves. The inflorescence is nodoso-racemose, the flowers being curved, and of a pale pink colour, the stamens 10, diadelphous, the style bearded at its upper part, and the stigma covered with a remarkable crescentic ventricular sac. The legume is 7 inches long, of a brown colour, containing two or three dark-brown seeds, with a long, deep hilum.

The paper was illustrated by drawings, executed by Dr Greville.

The following Donations to the Library were announced :—

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, Nos. 21–24. 4to.—*From the Academy.*

Transactions of the Pathological Society of London. Vol. X. 1859. 8vo.—*From the Society.*

Monthly Notice of. Astronomical Society. Vol. XX., No. 2. 8vo.—*From the Society.*

Journal of the Geological Society of Dublin. Vol. VIII., Part 2. 1859. 8vo.—*From the Society.*

Instructions and Chart for Observations of Mars in right ascension at the opposition of 1860 for obtaining the measure of the Sun's distance. By G. B. Airy, Esq., Astronomer-Royal. 8vo.—*From the Royal Astronomical Society.*

Memoirs of the Geological Survey of India. Vol. II., Part 1. 1859. 8vo.—*From the Indian Government.*

Atti dell' I. R. Istituto Lombardo di Scienze, Lettere ed Arti. Vol. I., Parts 12–14.

Ofversigt af Kongl. Vetenskaps-Akadémiens Förhandlingar. 1858. 8vo.—*From the Royal Society of Sciences of Stockholm.*

Berättelse om Framstegen i Fysik under år 1853, af E. Edlund. 1859. 8vo.—*From the same.*

Berättelse om Framstegen i Insekternas, Myriapodernas och Arachnidernas Naturalhistoria för 1855 och 1856, af C. H. Boheman. 1859. 8vo.—*From the same.*

Kongliga Svenska Fregatten Eugenies resa omkring Jorden under befäl, af C. A. Virgin. Aren., 1851–1853. Häft 6. 1859. 4to.—*From the same.*

Kongliga Svenska Vetenskaps-Akadémiens Handlingar. Bd. II. Häft 1. 1857. 4to.—*From the same.*

The Assurance Magazine and Journal of the Institute of Actuaries. Jan. 1860. 8vo.—*From the Institute.*

Madras Journal of Literature and Science. New series. Vol. IV., No. 8. 8vo.—*From the Madras Literary Society.*

Monthly Return of Births, Deaths, and Marriages. Dec. 1859.—*From the Registrar-General.*

Beretning om en Zoologisk Reise i Sommeren, 1858, af D. C. Danielssen. 8vo. *From the Author.*

Diplomatarium Norvegicum. 1858. 8vo.—*From the Royal University of Christiania.*

Personalier oplœste ved Hans Majestaet Kong Oscar den I's. begravelse i Ridderholmskirken. 1859. 8vo.—*From the same.*

Tale Ved det Norske Universitets Mindefest for Kong Oscar, den 22de Sept. 1859, af J. S. Welhaven. 8vo.—*From the same.*

Al-Mufassal, opus de re grammatica Arabicum Auctore Abu'l-Kasim Mahmûd Bin Omar Zamahsario. Edidit J. P. Broch, Christiania. 1859. 8vo.—*From the same.*

Navne-Register. 1858. 8vo.—*From the same.*

Det Kongelige Norske Frederiks Universitets Aarsberetninger for 1856–58.—*From the same.*

Nyt Magazin for Naturvidenskaberne. 1859. 8vo. 10de Binds, 4de Hefte, and 11te Binds, 1ste Hefte.—*From the same.*

Karlamagnus Saga Ok Kappa Hans. Udgivet af C. R. Unger, Christiania. 1859. 8vo.—*From the same.*

Forhandlinger i Videnskabs-Selskabet I. Christiania. Aar 1858. 8vo.—*From the same.*

Uber die Geometrische Repräsentation der Gleichungen zwischen zwei veränderlichen, reellen oder komplexen Grössen, von C. A. Bjerknes. 1859. 4to.—*From the same.*

Proceedings of the Horticultural Society of London, No. 8. Jan. 1860. 8vo.—*From the Society.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. IV. 1859–60. No. 52.

Monday, 16*th January* 1860.

The following Gentlemen were duly elected Ordinary Fellows:—

William Robertson, M.D., F.R.C.P.E.
Frederick Guthrie, B.A., Ph. D.
James A. Wanklyn, M.R.C.S. Lond.

Monday, 6*th February* 1860.

Sir DAVID BREWSTER, Vice-President, in the Chair.

The death of General Sir Thomas Makdougall Brisbane, Bart., G.C.B., President of the Society, was announced, as having taken place at Brisbane on 27th January; thereupon the following motion was made by Lord Neaves, one of the Vice-Presidents of the Society, and unanimously agreed to:—

"That the Society, at this its first meeting after the death of Sir Thomas Makdougall Brisbane, should place upon record the expression of its deep regret for that event, and its high estimate of the character of Sir Thomas Brisbane, who, besides other eminent public services, was during a long life conspicuous as a sincere lover and active promoter of science, and who so worthily presided over this Society for a period of twenty-seven years.

"That an excerpt from this minute be sent to Lady Makdougall Brisbane, with an expression of the Society's sympathy and condolence."

The following Communications were read:—

1. On the Capture of Whales with the aid of Poison. By Dr Christison.

This paper was an account of a plan proposed and tried many years ago for poisoning whales, by introducing hydrocyanic acid into their bodies when struck with the harpoon.

In 1831, the author was consulted on the subject by the late Messrs G. and W. Young of Leith, at that time concerned in the northern whale-fishery. It appeared to the author that the idea was feasible; that it was sufficient to paralyse the animal, so that the boats could speedily come up with it; and that a quantity of concentrated hydrocyanic acid, adequate to produce that effect at least, could be introduced by means of two glass tubes, one on each side of the shank of the harpoon, where they would be protected by the barbs of the blade. After various devices were thought of for breaking the tubes at the right moment, the contrivance fixed on was, that the double barb, with which each side of the blade terminates, should be jointed movably on the upper portion of the blade; so that, when traction was exerted, on the whale starting off with the harpoon in its body, the external ends of the barbs would be thrown outwards so as to increase the hold of the harpoon, while the inner ends of the barbs would be squeezed against the tubes, and crush them to pieces.

Harpoons so constructed, one of which was exhibited to the Society, were sent out in a Greenland ship, with a large supply of concentrated hydrocyanic acid, in the spring of 1832; but the ship was nipped between two ice-fields on its first arrival among the whales, and just when all was ready for the trial. In 1834, another vessel was sent out by the Messrs Young, provided with the same kind of harpoons, and with a harpoon gun for firing them. Not having been aware till lately of this second trial, the author had been able to inquire into the result only a few weeks ago. The accounts he received were discrepant. According to the most credible report, the experiment succeeded; but the crew were so alarmed at the effects, that they were afraid of being poisoned in removing the blubber, and would not persevere in using the harpoons.*

The paper concluded with observations, showing that increased facilities might be secured, in consequence of the comparative ease with which concentrated prussic acid might now be made and preserved in hermetically sealed tubes, and likewise because poisons were now known even more potent than hydrocyanic acid.

2. Notice regarding the Branchial Sac of the Simple Ascidiæ. By Andrew Murray.

In a paper which I read last year before this Society, "On the Structure and Functions of the Branchial Sac of the Simple Ascidiæ," I stated that I had fed and injected ascidiæ with indigo and other coloured sea-water, and that in those so fed, the coloured material was never found on the exterior of the sac, but always deposited on the inner wall, and that injection by the mouth into the sac failed to push the coloured matter through its walls, except by rupturing them.

These experiments were not isolated or few in number. I showed the results to various friends—among others, Professor Goodsir, Dr Wright, and Dr Cleland—and never, in any of the experiments which I made, did a single instance occur of the indigo passing through the stigmata of the sac; and, in that paper, I naturally reasoned from this fact. Subsequent observation has shown me that, in relying upon these negative instances, I was generalising too hastily. Since I read that paper, I have in two instances found, on feeding the *Ascidia virginea* with indigo, that it had passed through the windows of the sac and was partially deposited on each side of the sac, and some of it sticking in the meshes; and I hasten to correct the erroneous impression conveyed by the negative instances in my former paper. Of course, all the reasoning in it, founded on the supposed impenetrability of the sac, falls to the ground; and it would appear that my error has arisen from the animal having the power of rejecting or passing through these stigmata the contents of the sac as it pleases, which accounts for various other observers having seen

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* Since the Author's paper was read, he has received distinct information, that at the first trial, the whale "sounded," but in a surprisingly short time came up again—dead.

currents running past the fenestræ without entering them; and my previous experiments probably failed from the fact of the indigo being distasteful to the animal, which exercised its power of not admitting it to pass the walls of the sac.

Another correction which I wish to make is this: I stated that Dr Wright and I thought that, under a high power of the microscope, we saw a diaphanous membrane stretching across the branchial stigmata, which showed a polygonal structure similar to that of epithelica. I have never been able to detect this again; but I have seen something approaching to it, which I am satisfied was a compressed aggregation of blood-globules, and I strongly suspect (particularly since finding that the indigo has passed through these stigmata) that my former observation is to be referred to some deceptive appearance of this kind.

The following Gentleman was elected an Ordinary Fellow—

Professor MACDOUGALL.

The following Donations to the Library were announced:—

On Hypsometrical Measurements by means of the Barometer and the Boiling-Point Thermometer. By J. Burgess, F.E.I.S., Calcutta, 1859. 8vo.—*From the Author.*

Reminiscences of General Sir Thomas Makdougall Brisbane, of Brisbane and Makerstoun, Bart. Printed for private circulation. 4to. 1860.

Memorial on the new system of Dioptric Lights, invented and introduced by Sir David Brewster, K.H., to the Lords Commissioners of Her Majesty's Treasury. 8vo. 1859.—*From the Author.*

On the Life-Boat, the Lightning-Conductor, and the Light-House. By Sir David Brewster, K.H.—*From the Author.*

Transactions of the Royal Scottish Society of Arts. Vol. V., Part 3. 8vo. 1860.—*From the Society.*

Schriften der Universität zu Kiel, aus dem Jahre, 1858. 4to.—*From the University.*

Charts and Sailing Directions.—*From the Dépôt de la Marine.*

Monday, 20*th February* 1860.

DR CHRISTISON, Vice-President, in the Chair.

The following Communications were read:—

1. On the Action of Uncrystallised Films upon Common and Polarised Light. By Sir David Brewster, K.H., F.R.S.

Since the discovery of the polarisation of light by refraction, the action of a pile of transparent plates upon common and polarised light has not been studied by any of the writers on physical optics. It was believed that a pencil of common light was completely polarised in the plane of refraction when the plates were sufficiently numerous, no special notice having been taken of the light thrown back by reflexion into the transmitted and polarised beam. Sir John Herschel, indeed, had referred to it; but he remarks that "it mixes with the transmitted beam, and, being in an opposite plane, destroys a part of its polarisation."* So long ago as 1814, Sir David Brewster had shown that this reflected light is distinctly visible as light polarised by reflexion;† but owing to the difficulty of procuring very thin plates of glass with perfectly parallel surfaces, it was impossible to ascertain the true character of the oppositely polarised pencils.

Having obtained, however, films of decomposed glass of great thinness, and perfectly colourless, the author was enabled to prove that the transmitted beam consisted of two pencils oppositely polarised, and that when polarised light was incident obliquely on such a pile, and subsequently analysed, the pile of films exhibited all the properties of a plate cut perpendicular to the axis of a negative uniaxal crystal, the tints produced by the interference of the pencils rising to the *blue* of the second order of Newton's scale of colours, by increasing the obliquity of the incident pencil.

A line perpendicular to the plates or films at the point of incidence corresponds with the axis of the uniaxal crystal; and the different azimuths in which the polarised ray may be inclined to this axis correspond with the principal sections of the crystal.

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* Treatise on Light, Art. 868.

† Phil. Trans., 1814, p. 226.

When the films of decomposed glass are circular spherical segments and colourless, the black cross and its accompanying tints are finely displayed, as in the system of rings seen along the axis of uniaxal crystals. When the films have the colour of thin plates, and are deeply spherical segments, the tints of the rings which accompany the black cross are singularly modified.

2. On Mr Darwin's Theory of the Origin of Species.

By Andrew Murray.

The position taken by Mr Darwin is, that all species have arisen by the natural process of ordinary generation. That the differences which we now see in them have arisen from slight variations in individuals having from time to time occurred, which have been perpetuated by inheritance, by successive stages and slow degrees, through unlimited spaces of time. Some of these slight variations he considers to originate in causes beyond our power of explanation, and which, although not the work of chance, we may call chance, for want of a better appellation—others to arise from habit, or from the excessive use or disuse of certain organs; but that when such a variation has once appeared, it is preserved by hereditary descent through a principle which he calls "natural selection," and which he deduces as a corollary from the struggle for existence which we see constantly going on around us. "As many more individuals," says he, "of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary, however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be *naturally selected.* From the strong principle of inheritance any selected variety will tend to propagate its new and modified form" (p. 5). Mr Darwin by no means shuns pushing his theory to its legitimate conclusion. In arguing as to the acquisition of new habits by some of his supposed transitional animals, he says, "In North America the black bear was seen by Hearne swimming for hours with widely-open mouth, thus catching, like a whale, insects in the water. Even in so extreme a case as this, if the supply of insects were constant, and if better adapted competitors did not already exist in the country, I can see no difficulty in a race of bears being rendered by natural selection more and more aquatic in their structure and habits, with large and larger mouths, till a creature was produced as monstrous as a whale" (p. 184).* And the final conclusion to which he has arrived is summed up as follows:—"Analogy would lead me one step farther, namely, to the belief that all animals and plants have descended from some one prototype. But analogy may be a deceitful guide. Nevertheless, all living things have much in common in their chemical composition, their germinal vesicles, their cellular structure, and their laws of growth and reproduction. Therefore, I should infer from analogy, that probably all the organic beings which have ever lived on this earth have descended from some one primordial form into which life was first breathed" (p. 484).

Such is a general statement of the position taken by Mr Darwin; and in support of it, as might be anticipated from so accomplished a naturalist, we have in his work not only the chief arguments on which it rests ably stated, but numerous phenomena and facts in natural history applied to it, so as to test its probability by its consistency or inconsistency with them. These illustrations form, however, only a very small portion of the facts which he has accumulated, and which, he informs us, will be afterwards published in a larger and more elaborate treatise, and are now to be looked upon as no more than mere indications of the nature of the evidence he possesses, and proposes hereafter to adduce. A few of the most important of these I shall briefly notice, but I think their value may be perhaps better appreciated if I first state what I consider to be the essential qualities requisite for the existence and preservation of a species. I conceive that all species bear implanted within them two essential laws, without which they could not exist. The one, a power of accommodating themselves to a certain extent to circumstances; in other words, a power of modification or variation, as Darwin calls it. Without this the individuals composing the

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* In quoting this, I do not at all mean to give it as a fair illustration of Mr Darwin's views. I only refer to it as indicating the extent to which he is prepared to go. The example here given I look upon (as I have reason to know Mr Darwin does himself) merely as an extreme and somewhat extravagant illustration, imagined expressly to show in a forcible way how "natural selection" would operate in making a mouth bigger and bigger, because more advantageous.

species would, under any change of circumstances, die, and, of course, the species would die with them. Now, it is not difficult to prove that this power of modification is possessed by plants and animals. I may instance the change which takes place in the wool of sheep, according as the animal is transferred from one climate to another—the change in the size of the chest and lungs which is said to take place in the second generation of animals transported from ordinary elevations to the intensely rarified air of lofty mountains, or the alteration that is found in shells, whether fresh-water or marine, when transferred into brackish water. But for evidence of this I need not go beyond the examples given by Mr Darwin himself. I think that all the instances of variation mentioned by him may be referred to this principle of modification. To this principle, and as designed for a similar purpose, do I refer the phenomena of hybridization. Putting aside a few exceptional cases, which may be explained on special grounds, I conceive that the well-known and undeniable general fact, that two distinct species may produce hybrid offspring, which hybrid offspring will be sterile either in the first or second generation, is strictly an instance of modification, allowed and intended for the preservation of the species. Conceive, for instance, a herd of deer, or any other animal, of which all the males have died off—conceive it to be the last herd of that species on the face of the earth. Except for this power of hybridization, the species is extinct, although it yet lives. Its propagation is at an end. No young can replenish its numbers, and the species endures only until the last individual has died off. But with the power of having fertile intercourse with a distinct species, another chance is given for its preservation. A hybrid is born; and if a male, it can have fertile offspring from the females of the original herd, and in a few generations all trace of the foreign blood will have been washed out. Such, I conceive, to be the uses of the principle of modification in its various phases, viz., the preservation of the species by the preservation and propagation of the individual. But the species may be lost in another way than by the death of its component individuals. It might, were there no check upon this power of modification, be lost by hybrids and modified individuals taking the place of species; in fact, were the power of variation unlimited and uncontrolled, all species would be confounded, and there would be nothing but an indiscriminate mass of creatures running all into each other, as should be the case under Mr Darwin's theory were it true in fact.* Centaurs and mermaids, nay, even dryads, would cease to be impossible fables, and the beauty of creation would be lost in one undistinguishable chaos. To guard against this, and to preserve species from extinction by confusion, as well from extinction by death, nature has furnished species with another attribute as a counterpoise to the facility of modification and variation, and that is the tendency to reversion to type. This is seen working in two ways; the one in the reappearance of typical forms or peculiarities after having been absent for one or more generations. We see it well in our own race, where a parent's face and talents, lost in the child, reappear in the grandchild—where even hereditary diseases show themselves after the intermission of a generation or two. This phase of reversion to type is slightly alluded to, and slightingly admitted as an element by Darwin. But the second, and, as it appears to me, by much the most important phase of reversion to type (and which is practically, if not altogether ignored by Mr Darwin), is the instinctive inclination which induces individuals of the same species by preference to intercross with those possessing the qualities which they themselves want, so as to preserve the purity or equilibrium of the breed. I again refer to our own race for an apt example. It is trite to a proverb, that tall men marry little women, tall women little men; a man of genius marries a fool, a great beauty the ugliest man she can find; and we are told that this is the result of the charm of contrast, or of qualities admired in others because we ourselves do not possess them. I do not so explain it. I imagine it is the effort of nature to preserve the typical medium of the race. Did a different feeling prevail, we should have our species broken up into giants and dwarfs, Newtons and idiots, Venuses or Apollos and satyrs, Sampsons and weaklings; or, if we should adopt Darwin's notions, the dwarfs, weaklings, and idiots, would all be extirpated by the predominancy of the stronger varieties. Now we know that this is not the case;

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* One of Mr Darwin's explanations of the absence of intermediate forms may be taken as his answer to this objection—viz., that these forms are, in point of fact, numerically weaker than the forms on each side which they link together, and thus are liable to be exterminated sooner than them. But, admitting the fact to be that they are less numerous, why should they be so under Mr Darwin's theory? With unlimited powers of modification, why should the intermediate forms always be *originally* fewer.

and we may guess how strong the instinctive inclination for reversion to typical form is, when we look abroad among our acquaintances and see, notwithstanding the manifold inducements to disregard the promptings of nature consequent upon the artificial state in which we live, how few have refused compliance to this mysterious law. The control of parents, the desire for easily acquired wealth, the promptings of ambition, the cravings of vanity, and the accidents of opportunity, all suggesting other matrimonial connections, and, backed with what may be looked on as of more importance than either, the strong control over one's own feelings and desires acquired by the habits of civilised life, generally give way before this imperious constraint for reversion to type. It is less easy to give similar evidence of this phase of the revertive principle in other animals. In the wild, we only see its result in the uniformity of all individuals; in the domestic, man interferes, and by his breeding compels departure from the type, and increases it. But I believe it requires man's greatest care and watchfulness to prevent reversion, and that a breed neglected retrogrades in a very short time; and what is called the prepotent influence of pollen from the typical plant over that of neighbouring varieties is an instance which will be admitted by most hybridizers; and an analogous influence may be equally exercised in the case of hermaphrodites and fixed animals. This is my belief: but it is not that of all; the *possibility* of the new variety made by breeders and gardeners reverting to their parent forms is doubted by many, and denied by some. Mr Darwin of course disputes it, or at least does not admit it, and desiderates the evidence on which the statement has been so often made, that our domestic varieties, when run wild, gradually but certainly revert in character to their aboriginal stocks. Such a demand for proof may not be capable of immediate satisfaction. But where a fact is very generally accepted* as true, it will usually

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* The point is one well worthy the attention of those who may have the opportunity of testing it. I have no doubt that many unscientific breeders could give at once instances which would bear upon it; but it will be observed that the question of whether they do bear upon it is one not unattended with difficulty: for instance, in our breeds of cattle how are we to know when a race or variety is reverting to its parent type—what was the parent form of our domestic cattle?—*Quien sabe.* But that they naturally retrograde or go away from the something which has been the aim set up in breeding to something else, certainly cannot be denied.

be found to be based on some foundation. *Vox populi, vox Dei*, is true in more sciences than politics. Passing this, however, I would next notice that the phenomena of hybridization do not stop with the law allowing the hybrid to have fertile offspring from the parent stock; there is another law which prevents it having such offspring from other hybrids or other species, and this is quite in accordance with my view of the precautions adopted by nature for the preservation of species. In the first place, *fertility*, to preserve it from extinction by extirpation of individuals; in the second place, *sterility*, to preserve it from extinction by confusion of races. Such are my views of the purpose and working of the compensating qualities implanted in species. And my first objection to the principles on which Mr Darwin's theory rests is, that it is founded on exaggerated and undue estimate of the one—the power of modification; and if not a negation, at least an inadequate concession of the other, viz. the principle of reversion to type.

Seeing, then, that the power of modification or variation is the principle on which his whole superstructure rests, Mr Darwin wisely takes care to fortify it by adducing striking instances illustrative of the extent to which this may take place. As the power of modification is to be seen in its most developed form in domestic animals, it is from them chiefly—indeed, so far as support to his theory goes, I may say it is from them entirely—that his illustrations are drawn. Now, it is usually said that domestic animals are not fair examples from which to reason in inquiries into species and their origin; and it is thought that the artificial circumstances under which they live alter their system so much as to render any argument drawn from them not worthy of reliance. I have no doubt that such artificial life and great change of habits has an important effect upon these animals, and more especially upon their reproductive system, different conditions of which (as Mr Darwin has well shown) have much effect in inducing subsequent variations in their descendants; but, as already said, I imagine a still more potent cause of the greater variability of domesticated animals to lie in their being deprived, through the agency of man, of the opportunity of allowing the revertive principle to come into operation by intercrossing. But it is no part of my argument to dispute the power of variation within certain limits; and as, for the above reasons, I admit them to be greatest in domesticated species, I need not dally over the instances given by Mr Darwin, however interesting and suggestive they may be. I shall merely observe, with regard to those facts which he adduces as instances of natural variation, in contradistinction to artificial or domesticated variation, that they are limited, and consist (as it appears to me) entirely of such minor modifications as I have already alluded to, as permitted more or less in all species for the preservation of the individual. Seizing upon the variations (of which there is no want) which have given rise to disputes among naturalists as to whether particular forms are mere varieties or true species, he thence infers that these are species in the course of transmutation. That some naturalists, with too quick a perception of differences, should attempt to make species or sub-species out of varieties, should not prejudice the question; the blunders of the few are frail ground on which to rest a theory; and if the concurrent opinion of the majority be taken, the number of forms as to which doubt may fairly be entertained is comparatively few. And this Mr Darwin, with his usual fairness, frankly admits. "It may be asked," says he, "how is it that varieties which I have called incipient species become ultimately converted into good and distinct species, *which in most cases obviously differ from each other more than do the varieties of the same species*;" and he sets himself to account for this, but does not dispute the fact. He gives no instance of any wild plant or animal, subject to no restriction as to intermixture, having within the knowledge of man deviated into a well-established constant form, which would be admitted as a species by naturalists. He refers to Mr Buckman's experiments, as showing the extent of variation capable of being assumed by plants: but, on the one hand, these experiments may be classed as instances of artificial selection; and on the other, I hear (I have no personal knowledge on the subject) that there is considerable difference of opinion among botanists as to their trustworthiness. And even although they were trustworthy, their result is merely to show how various the modifications are which take place under altered circumstances, a fact which I do not deny. A writer in the "National Review" offers to supplement such instances by quoting from M. Roulin two naturally modified breeds of cattle descended from the cattle of the Pampas, and now found in the hottest parts of South America; one of them called *Pelones*, and the other *Calougas;* the former possessing a very scanty fine fur, and the latter without any hair at all, and each peculiar to the district it inhabits, and either not transferable, or with difficulty transferable, into any colder region. He thinks that these would be admitted as species by naturalists. Far from it. It is merely a simple case of modification to suit altered condition of life. It is exactly the same case in oxen as we see in the Merino and Australian sheep; but such a variation is not what we desiderate. Show us an animal between the ox and the sheep, or rather a series of animals exhibiting the transitions between them. But Mr Darwin, in reply, tells us, that we cannot expect to trace these new species in their actual transit. While commencing their variation, we call them varieties; when they are farther removed, we dispute which they are; when they are complete, we call them species. He with some justice (but not entire justice) remarks, that we are here, as compared with the great spaces of time which he requires for the development of his new species, merely at a single point of view, and at no one point can you expect to see a passage taking place, because the assumption is that every passage is gradual. We see the present species; but we do not know that we either see its parent or its descendant. I admit that, under such premises, we cannot see the passage; but surely over the whole surface of the earth, and out of all the living creatures swarming upon it, we ought to detect some species whose parents have not yet perished, and whose descendants have already appeared. Mr Darwin would like to escape from this position—but he cannot. He says "It should always be borne in mind what sort of intermediate forms must on my theory have formerly existed. I have found it difficult, when looking at any two species, to avoid picturing to myself forms *directly* intermediate between them. But this is a wholly false view; we should always look for forms—*intermediate* between each species, and a common but unknown progenitor" (p. 280). Now this is merely confusing the thing; the process being gradual, there must be some exactly and directly true half-way intermediate form between the parent species and the descendant species, and it matters not to us that we know only one of these, nor does it matter that we know neither. What concerns us is, that there ought to be half-way steps between every form and something else which is either now living, or which has lived, on the face of the earth, and if such do exist, we ought to find,—I do not say all,—but certainly many, or at least some of these. So far as regards the present age, Mr Darwin apologises for the absence of such intermediate forms, by supposing migrations to have taken place over large continuous areas, and the links to have been lost in the intermediate districts from unsuitableness of condition, or from geological changes having submerged certain districts, when, of course, the links existing here would be lost, and concludes a very specious and plausible argument on this head thus:—" Lastly, looking not to any one time, but to all time, if my theory be true, numberless intermediate varieties, linking most closely all the species of the same group together, must assuredly have existed; but the very process of natural selection constantly tends to exterminate the parent forms and the intermediate links, consequently evidence of their former existence could be found only amongst fossil remains" (pp. 177–9). Now, so far as these explanations are merely an answer to the question, Why we do not find such intermediate passages in any one particular portion of the globe? they might be accepted as an apology for their absence; but when applied to the whole of it, and to such myriads of creatures as inhabit it, it seems beyond all reasonable application of the doctrine of chances to accept it as a sufficient or even probable explanation. The very essence of the new theory is gradual passage, and slow descent by natural generation and inheritance—the parent species and the incipient species both subsisting at the same time, and the process of substitution being gradual and protracted. Mr Darwin's own map of divergence, and the whole of his reasoning go to show how parent forms, and descendant and collateral forms, may all subsist and be going on in different localities and climates at the same time. It will not therefore do to say that the new varieties developed by natural selection " continually take the place of, and exterminate their parent forms," and so prevent the occurrence of innumerable intermediate links everywhere throughout nature. But supposing that, for the sake of argument, we allow this apology for the moment, at least it can only apply to the present age of nature, or to some one definite period—it cannot also apply to past ages, or to any two or more consecutive ages; and Mr Darwin, as we have just seen, admits that " evidence of their former existence should be found amongst fossil remains" (p. 280). Are fossil remains of these then found? Is there any evidence in support of this to be drawn from fossil remains? Mr Darwin himself shall answer the question. "Why, then," says he, "is not every geological formation and every stratum full of such intermediate links? Geology *assuredly does not reveal any such finely graduated organic chain*; and this perhaps is the most obvious and gravest objection which can be urged against my theory" (p. 280). And a very grave objection it certainly is, that in the only two quarters where actual proof of facts (which must exist if the theory be true) can be sought for, and where, *à priori*, they might reasonably have been expected to be found, namely, the present and the past, they should be absent, or at least undiscoverable.

Those who are new to the subject may naturally be puzzled to guess how he escapes from such an embarrassing dilemma. The solution is abundantly simple. "The explanation," says he, "lies, as I believe, in the extreme imperfection of the geological record." Now I believe no one will dispute as an abstract proposition the extreme imperfection of the geological record. But I cannot admit that its imperfection is of that character or degree that will entitle Mr Darwin to plead it in his favour. He dwells on the poorness of our palæontological collections—the great spaces of time wholly, or nearly wholly, unrepresented in them—the extreme rarity of terrestrial animals in the deposits—the destruction of the soft parts of most animals, and the crushed state of many others. I shall not follow him into his details on these points. All that he says on the subject may be very true—is very true—but will avail him nought if, in any portion of the geological records, we can find any one succession of strata of moderate depth which may be fairly held to have been deposited unintermittently, and in which we find a liberal representation of the animals of any one class. And such records many of the enormous deposits of limestone rocks beyond doubt are—their whole phenomena indicating an uninterrupted period of tranquil deposition, extending over ages beyond our numbering, and the strata themselves bearing in their bosoms an excellent report on the molluscous animals of the period.* I have quite sufficient to test Mr Darwin's

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* Mr Darwin himself remarks, that "two palæontologists, whose opinion is worthy of much deference, namely, Bronn and Woodward, have concluded that the average duration of each formation is twice or thrice as long as the average duration of specific forms" (p. 293). This opinion may be well-founded or not—I imagine it is; but it is difficult of application to the point at issue, on account of the real or possible intermissions which may have taken place in these formations.

apology, if I have, first, a lengthened and uninterrupted period of deposit, and next, the marine fossils in any one class of that period well represented in it. If I am told that such representation in fossils is not only imperfect as regards terrestrial and soft animals, but also as regards molluscous shell-bearing animals, I shall go to issue upon the point, and, I think, prove that we ought to have, and do have, as good a knowledge of what were the species of shell-bearing molluscs which lived in the seas which produced many of our fossil deposits, as we have of those living at the bottom of our own seas at the present day; and no one will say that that knowledge is very imperfect. A moment's consideration of the respective means we have of knowing each will show the probability of this. The only means we have of knowing the species in our present seas is by dredging, or by the still more imperfect system of picking up those shells which may be cast ashore. Now, dredging is a mere scraping of a little morsel of the bottom of the sea here and there; and yet, by adding up the accumulated observations made in various quarters, we have arrived at a most accurate knowledge of the inhabitants of those seas which have been examined. Some shells remain rare, others unique, but this does not prevent us believing in the accuracy of our knowledge. Compare this scraping here and there in the dark, with the deliberate open-day examinations which we can make of most geological strata; miles upon miles of coast cliffs—transverse sections in ravines—and piece by piece manipulation in quarries and mines—and I think it must be admitted, that so far as that class of animals which *can* be preserved in deposits goes, it cannot be said that our knowledge of them in continuous strata is imperfect; and as, therefore, we should there find the intervening links between older and younger species if they existed, and yet do not find them, the inevitable inference is that they do not exist.

Untenable as they appear to be, however, these arguments or apologies have satisfied Mr Darwin, and his system of natural *variation* being once admitted or held as proved, the remaining steps to natural *selection* are easy. The most essential, and one as to which I do not suppose there can be any difference of opinion, is founded on what he calls the struggle for existence. That such a struggle is constantly going on is familiar to us all; but, as I neither dispute its existence nor its bearing (always supposing his other premises to be correct), I shall not make any remarks upon it, or on some of the other minor branches of his argument, such as sexual selection, divergence of character, the effects of use and disuse, acclimatization, laws of variation and geographical distribution (on all of which, had I space and time, I see much which I feel disposed to modify or controvert). These must either stand or fall with the other parts of his theory already noticed, or do not come into direct collision with the more vital objections which I have to it. There is, however, one topic still remaining which I should not wish so to pass over—viz., the effect of physical condition in influencing form originally, and affecting it afterwards. On this point Mr Darwin and I are widely at issue. He believes that it has had little or no influence upon them. "Neither the similarity nor the dissimilarity of the inhabitants of various regions," says he, "can be accounted for by their climatal and other physical conditions." To me, again, it appears that the effect of physical condition is one of the most powerful agents in determining the form of organic creatures; and I must be pardoned if I devote a few sentences to this part of the subject, because I look upon it as of the greatest importance, and ranking in the same category and scarcely less powerful as a proof of design on the part of the Creator than that drawn from the anatomical structure of the animal frame. Some of the instances bearing on it, given by Mr Darwin, are certainly difficult of explanation; but then, how little do we know of what the real essence of physical condition is! Look at North America, which in temperature and many other respects has a physical condition not greatly differing from our own. See how the inappreciable difference in physical condition is telling upon the white race there; the women in youth retaining the normal beauty of their race, but becoming prematurely old; the men becoming thin and sallow; the teeth decaying more rapidly; the average duration of life diminishing,—besides various other tokens of unsuitableness of climate. We all know very well that Bangalore, Darjeeling, and other hill stations in India, are mere expedients, better than nothing, but that the only real remedy for the sick Englishman is home,—home to the native physical condition. Seeing, then, that the essential part of physical condition is something of so subtle and undetectable a nature, is it a fair estimate of its effect to say, as Mr Darwin does, that certain large tracts in South Africa and South America are placed under like physical conditions; therefore, if there is any value in them, show us like product?

What! South America with its cordillera, and weeping Southern Archipelago, under similar physical conditions with arid South Africa? Even the unassisted eye can see that this is not so. But Mr Darwin chooses a test by which I am willing to abide (and which I had indeed selected for the same purpose in a paper I read on the Disguises of Nature at the meeting of the British Association at Aberdeen). It is the blind cave animals found in the limestone caverns both in Europe and America. Mr Darwin says, "It is difficult to imagine conditions of life more similar than deep limestone caverns under a nearly similar climate; so that on the common view of the blind animals having been separately created for the American and European caverns, close similarity in the organisation and affinities might have been expected; but as Schiodte and others have remarked, this is not the case, and the cave insects* of the two continents are not more closely allied than might have been anticipated from the general resemblance of the other inhabitants of North America and Europe." Now Mr Darwin, in this passage, has quite mistaken the gist of Schiodte's remark, and consequently misapplied it. It is quite correct for him to say that we should expect close similarity in the caves in question, but it is incorrect to say that "this is not the case;" for the similarity in some is marvellously close; and it is also incorrect to say that Schiodte and others have remarked that "this is not the case." As to the "others," indeed, I cannot speak, for I do not know to whom he refers, and I do not know any other author than Schiodte except Müller, who has written, from original observation, otherwise than incidentally upon the subject; but neither he nor Schiodte make any such remark. I presume the others alluded to by Mr Darwin are those who have followed Schiodte, and adopted or quoted his remark. The remark which he makes, and Mr Darwin has misapplied, is, "that the cave insects of the two continents are not more closely allied than might have been anticipated from the general resemblance of the other inhabitants of North America and Europe;"—a loose general remark, which, like an ancient oracle,

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* Although Mr Darwin here uses the observations of Schiodte upon blind insects as an illustration, his remarks (as he himself has had the kindness to inform me) are not meant to be confined to them, but also to be applied to the whole of the animals found in caves. But as his theory, if true, should meet every case, a clear flaw in even one would be fatal to the whole, and I would have tested it with these insects, whether they had been referred to by Mr Darwin himself or not.

may be read either way. Darwin (a disbeliever in the effects of physical condition), we see, reads it that the resemblance is slight; Schiodte, on the other hand, who appears to be a thorough believer in its effects, sees nothing more in the marvellous resemblance than might have been anticipated. I say that he seems to be a thorough believer, because he goes so far as to separate those insects which are found in stalactite caves from those in other caverns, maintaining (and I believe with justice) that the two kinds were respectively confined to these classes of caves. But let us see how the fact actually stands as to resemblance. I shall take the eyeless Anophthalmi. It is not the only one which would suit me, but it is the most striking. Although belonging to the family of Trechidæ, it possesses very marked and distinctive characters, besides the want of eyes. Nothing comes very close to it. It stands out and apart, and can be distinguished in a moment. It is found nowhere but deep in limestone caverns; but this generic form is repeated by *different species* in almost every cave which has been examined. In the caves of Adelsberg in Carniola, the two species *Anophthalmus Schmidtii* and *Anophthalmus Bilimekii* are found. *Anophthalmus hirtus* and *Anophthalmus Hacquetii*, in the Grotto of Krimberg in Oberiggdorf; *Anophthalmus Scopolii*, in the Grotto of Setz in Corinthia; *Anophthalmus Doriæ* in the Grotto des Ours in Eastern Liguria. *Anophthalmus Ghiliani* has been taken in a cavern at Monte Viso, near the French frontiers. *Anophthalmus Gallicus* and *Anophthalmus Pandellei* in the Grotto of Betharram in the low Pyrenees; *Anophthalmus Crypticola* and *Anophthalmus Orcinus*, in the Grotto of Gargas, high Pyrenees; *Anophthalmus Raymondi* in two caves near Marseilles; and *Anophthalmus Tellkampfii* in the Mammoth Caves of Kentucky, all confined to their own caves, or districts of caves, and found nowhere else. Now, how is this? When I first became acquainted with Mr Darwin's theory, it was from the perusal of the short notice of its main elements, published about eighteen months ago in the Linnean Society's Proceedings; and the imperfect account of it there given induced me to suppose that he held that every species was descended from the one nearest to it, and hence, to infer that he would hold that all the *Anophthalmi* were connected one with the other by direct descent, and I imagined that the fact of closely allied species being found in the caves of Kentucky and the caves of Carniola, without any means of communication with each other, must be fatal to his theory; but now that I understand it more correctly, I see that this difficulty can be got over by referring the two (as diverging descendants) to some common ancestor, not eyeless, who may have lived where the Atlantic Ocean now rolls, at some distant period when America and Europe were united. Therefore, the fact has not the significance I supposed. A *Trechus* may have wandered into each of these caves, and by process of natural selection, after frequent variation into all manner of other forms, which being unsuitable have not been preserved, have at last hit upon the form of an *Anophthalmus*. But if he thus saves his theory, what becomes of his disbelief in the effects of physical condition? If it has no effect, why have they all turned into *Anophthalmi?* The only explication which I can imagine for him is, that in every cave *Trechi* entered, and in each and all threw off descendants of all different kinds, as well as *Anophthalmi*, none of which were suited to the physical condition except the *Anophthalmi*, and therefore the latter alone survived. Whether this is a more philosophical explanation of their presence than the view that their production was influenced by the physical condition of the place, I leave to the reader to determine.

I shall only follow Mr Darwin for a few lines farther in his remarks on this subject. He says, "On my view, we must suppose that American animals having ordinary power of vision slowly migrated by successive generations from the outer world into the deeper and deeper recesses of the Kentucky Caves, as did European animals into the caves of Europe. We have had some evidence of this gradation of habit; for, as Schiodte remarks, 'animals not far remote from ordinary forms prepare the transition from light to darkness. Next follow those that are constructed for twilight; and last of all, those destined for total darkness.'" If Darwin reads this as meaning that there is a gradation in form and affinity between the animals which are found at the entrance, and those found in total darkness, he is in error—there is none. It is the gradation in adaptation to darkness that Schiodte is speaking of. Those at the entrance, with small eyes, belong to the *Pristonychi*, large black beetles found in cellars and such places. The *Anophthalmi* belong to the small *Trechidæ*, of which there are none specially found at the entrance.

I might take other exception to the facts adduced by Mr Darwin, or to his application of them. For instance, he says of the woodpecker, "Can a more striking instance of adaptation be given than that of a woodpecker for climbing trees, and for seizing insects in the chinks of the bark? Yet in North America there are woodpeckers which feed largely on fruit, and others with elongated wings which chase insects on the wing; and on the plains of La Plata, where not a tree grows, there is a woodpecker, *which in every essential part of its organisation*, even in its colouring, in the harsh tone of its voice, and undulatory flight, told me plainly of its close blood relationship to our common species; yet it is a woodpecker which never climbs a tree." (P. 184.) I have selected this instance both as a statement bearing upon the effect of physical condition which appears to me to require correction, and also as an illustration of the necessity, in such an investigation as this, of testing every fact before admitting it. This is a statement made upon Mr Darwin's own personal observation, confirming that of Azara. I do not believe there is a more upright and truthful man in Britain than Mr Darwin, and yet we look at things from such an opposite point of view, that I not only do not see what he avers in the above instance, but see quite the reverse. The woodpeckers he refers to are Colaptes (the La Plata species is, I believe, the *Colaptes campestris*); and so far from appearing to me to possess every essential point of the organisation of a woodpecker, they are one of the very instances which I have been in use to give as showing the alteration of structure in a type consequent upon different physical conditions of life. The Colaptes, although allied to the woodpeckers, differ from them in mode of life, inasmuch as they feed upon ants; and, in structure, inasmuch as not requiring that most essential part of the organisation of a woodpecker (its peculiar hammering bill and strong tail) they do not possess them, while they retain the peculiar tongue and accessory muscles still necessary for securing their insect food.

The strongest points in favour of the general results come to by Mr Darwin, are a class of facts which can scarcely be said to bear distinctively on his theory more than upon various other theories already promulgated, and more or less adopted. One of these is the fact, that all animals, and all plants, throughout all time and space, should be related to each other in group subordinate to group. Another not less formidable fact is the existence of the same homological parts in different animals, sometimes aborted, and sometimes largely developed.

These are two of the great difficulties attendant on the view of the independent creation of each individual species. But although they *were* fatal to that view, it does not fall to Mr Darwin as sole Œdipus to solve them. The doctrine of progressive development (to which Mr Darwin's view has many points of affinity), or any doctrine in which development of species *ex ovo* plays a part, will explain these facts equally well. The germ must bear some trace of its origin; and hence we should, under such a theory, see not only the relationships and homologies referred to, but also certain appearances which bear indications of reversion to type, such as the appearance of the stripes of the tiger in the young of the lion, &c. These, I own, are difficult to be explained (I do not say unexplainable) under the theory of independent creation, but natural, and to be expected, under any theory of development *ex ovo*,—not more under Mr Darwin's than under any other. The distinctive character of Mr Darwin's theory is not development *ex ovo;* that is the theory of Oken, of Agassiz, of the author of the "Vestiges of Creation;" nay, I may go farther back. It is the theory of Bonnet and of Priestley, who, however *involved* their ideas might be, still held "that all the germs of future plants, organical bodies of all kinds, and the reproducible parts of them, were really contained in the first germ." Darwin's, on the other hand, is gradual transition by slow and scarcely perceptible degrees; and, *so far as that specialty is concerned*, it has no more bearing than Oken's upon the classes of facts above referred to; and the distinction between them is not confined merely to the *modus operandi* of the process of development; it is much more material than that; it embraces the question of final causes, and bears on the very existence of design in the organic creation. The views of Agassiz and Oken do not challenge the fact of design existing in the wonderful adaptations of structure to purpose which we see everywhere displayed in living organisms. *Their* theory allowed us to retain our belief in the great argument on which the whole of natural theology is based; nay, even to place it on higher grounds, as the intelligence which performs its work by the intervention of a law or machinery designed by itself, and operating on a great scale, is superior to the intelligence which executes each individual detail directly and without such intervention. If it furnished no explanation of the causes of adaptation of structure to habit, at least it did not prevent us from holding, if we chose, that, by some unexplained means, the germ of life was supplied with such a principle of growth as, under certain physical conditions, developed itself into these adaptations. We could hold design still to be there, although its direct means of operation was shrouded from our view in the laboratory of Nature. But Mr Darwin's theory is not only opposed, but absolutely inconsistent with any such idea. The talons of the eagle have not been framed as they are by design, to seize and hold its prey. The wonderfully constructed hand of the mole was not a designed gift from the Creator, but merely some variety of the hedgehog, which had broadest paws, and, being most adapted to digging, adopted the mode of life of the mole. The implement was not made for the animal, but the animal for the implement. The assumption is, that it is not alone beneficial variations which Nature makes. She makes them in any and every way; some being profitable, others the reverse; and the reason why we find all that have ever been seen on the face of the earth beneficially endowed (that is, provided with structures which, to the unilluminated eye, indicate design) is, that only those variations which happen to have been so endowed have been preserved,—the blots which Nature made having become extinct through the preponderance of the beneficially endowed. To use Mr Darwin's words, "Natural selection is daily and hourly scrutinizing throughout the world every variation, even the slightest; rejecting that which is bad, preserving and adding up all that is good, silently and insensibly working whenever and wherever opportunity offers at the improvement of each organic being, in relation to its organic and inorganic conditions of life." (P. 84.) Now, I cannot believe in such doctrine. When I look at the anatomy of any part of the body, and see exactly the same mechanism and contrivances had recourse to which a mechanician would have used to secure similar results, I cannot bring myself to believe that it is fortuitous, or other than evidence of the presence of direct design. A belief in such design I should be most loath to surrender, and I am therefore glad that, on other grounds, viz. the legitimate result of the argument already discussed, I have come to be of opinion that Mr Darwin's theory is unsound, and that I am to be spared any collision between my inclinations and my convictions.

The following Donations to the Library were announced:—

London University Calendar. 1860. 8vo.—*From the University.*

Journal of the Proceedings of the Linnean Society. Vol. IV. No. 16. 8vo.—*From the Society.*

Bulletin de la Société des Sciences Naturelles de Neuchatel. Tome V. Part I. 1859. 8vo.—*From the Society.*

Maps of Indian Survey.—*From the Government of India.*

On a New Method of Measuring Watch-Glasses. By Alexander Bryson, F.R.S.E. 1860. 8vo.—*From the Author.*

Almanaque Nautico para 1861, Calculado de Orden de S. M. en el Observatorio de Marina de la Ciudad de San Fernando. Cadiz, 1859. 8vo.—*From the Observatory.*

The Canadian Journal of Industry, Science, and Art. January, 1860. 8vo.—*From the Canadian Institute.*

Maps, Sections, and Descriptions of the Geological Survey of Great Britain.—*From the Director-General of the Survey.*

Account of the Illness and Death of Dr William Pulteney Alison. By Patrick Newbigging, M.D., F.R.C.S.—*From the Author.*

Monday, 5th March 1860.

Dr CHRISTISON, Vice-President, in the Chair.

The following Communications were read:—

1. On the Utmost Horizontal Distance which can be Spanned by a Chain of a given Material. By Edward Sang, Esq.

The method of investigation followed in this paper for finding the limit for a uniform chain, is to suppose a multitude of catenaries all having a common vertex, and to take, in each of them, that point at which the tension is fixed. The curve passing through all of these points has for its equation—

$$z = s\,(1 - \sin\theta),$$
$$x = s\ .\ \sin\theta\ .\ \text{nep log cot}\ \frac{\theta}{2},$$

in which s is the tension, z the vertical, and x the horizontal ordinate.

This curve, a correct figure of which was exhibited, has its extreme horizontal limit when $\theta = 33°, 32', 03''$, from which the utmost horizontal span of a uniform chain is found to be $s \times 1{\cdot}325\,4838$, the height or versed sine being $\times 447\,5659$, and the length of the chain $s \times 1{\cdot}667\,1130$ when s is taken equal to the modulus of strength of the material.

This, however, does not show the absolute limit; for, by reducing the thickness of the chain at each point till it be just able to bear the strain to which it is subjected, we shall remove all redundant weight. The form which such a chain assumes may be called the catenary of regulated strength.

Its equations are—

$$i = \frac{x}{s}$$

$$z = s\ .\ \text{nep log sec}\ \frac{x}{s}$$

$$l = s\ .\ \text{nep log tan}\left(\frac{\pi}{4} + \frac{x}{2s}\right)$$

i being the inclination of the curve to the horizon. This curve has two vertical asymptotes placed at the distance πs from each other, which distance is thus the absolute extreme horizontal span that can be reached by a chain having s for its modulus of strength. A correct drawing of this curve was also shown.

2. On the Climate of Edinburgh for Fifty-six Years, from 1795 to 1850, deduced principally from Mr Adie's Observations; with an Account of other and earlier Registers.—On the Climate of Dunfermline, from the Registers of the late Rev. Henry Fergus. By Professor J. D. Forbes.

The paper on the Climate of Edinburgh is divided into seven sections.

The *First Section* includes an account of the earliest records of the thermometer at Edinburgh which are to be found in the *Edinburgh Medical Essays*. They date from 1731. They were made with a thermometer having an arbitrary scale, which is described in *Martine's Essays*, and they appear to have been recorded with much care; but they cease in 1736. The next series, printed in the *Essays of the Philosophical Society of Edinburgh*, commence in 1764, and are continued till 1770. A parallel Register was begun at Hawkhill, near Edinburgh, and continued till 1776, and probably later. Professor Playfair's Observations (printed in the Royal Society Transactions) only supply one year (1794) of the interval which elapses before we enter upon the elaborate Register kept by the late Mr Adie and his family.

Second Section. Mr Adie's Observations were continued from 1795 to the middle of 1805. They then ceased until the year 1821, after which they were steadily pursued, with the assistance of different members of his family, until 1850. In order to supply the missing years 1805–1820, the author was fortunate enough to recover (through the kind agency of Mr David Laing) a Register kept at Dunfermline for above thirty years by the late Rev. Henry Fergus, whose son, the Rev. John Fergus, kindly lent the Register, and allowed him to make use of it.*

The history of this Register and its results are given in a short separate paper. The climate of Dunfermline has a very close approximation in character to that of Edinburgh, not only as regards the mean annual temperature, but also as to the distribution of heat at different seasons.

By availing himself of the Dunfermline Register for the years 1805–1820, and using simple reductions, the author is enabled to estimate with considerable confidence the mean temperature of each year, and each month of each year, from 1795 to 1850, at Edinburgh.

The *Third Section* contains the monthly means of the entire series in a tabular form. The highest mean annual temperature (49°·60) was that of 1846, the lowest (44°·44) that of 1799. The mean of the whole period, deduced from nearly 35,000 observations, was 46°·77, or, excluding the Dunfermline observations, 46°·88. A series of Tables is also given, classifying the seasons according to the annual range, and by the temperature of the hottest and coldest months respectively. The hottest month was July 1808, the coldest,

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* Mr Fergus has, since this paper was read, presented this interesting MS register to the Royal Society.

January 1814. In 56 years June was 5 times the hottest month, July 36 times, and August 15 times. November was twice the coldest month of winter, March 1½ times, February 10½ times,* December 15, and January 27 times. A classification of the years according to the earliness or lateness of the greatest summer heat is next given.

Section Fourth contains the monthly and annual fall of rain from Mr Adie's observations, viz. from 1795 to 1804, and from 1822 to 1849. The mean annual fall is exactly 25 inches, ranging from 36·60 in 1795 to 15·27 in 1826. The distribution of rain in the different seasons is then given, being greatest in summer and least in spring.

In *Section Fifth*, the author has considered whether any law can be traced in the succession of the seasons throughout the period embraced by these observations. But beyond the fact, that hot and cold years usually occur in groups of from 7 to 12 years' duration, nothing definite can be deduced from the Tables. Conformably with this remark, there is a slight appearance of maximum temperatures occurring about the years 1809, 1829, and 1849; and of minima in 1799, 1819, 1839.

Section Sixth is on the form of the Annual Curve of Temperature and its Fluctuations. Adopting the usual mode of notation by the sines of arcs, and making the given date reckoned from January 0 (the extent of the year being denoted by 360°), we have for the temperature, y, of the given epoch x.

$$y = 46°{\cdot}88 - 10°{\cdot}98 \sin (x + 68° \; 28') + 0°{\cdot}96 \sin (2\,x + 22°).$$

The average temperature of each day of the year being taken for the 40 years of Mr Adie's observations, and being projected in a curve, is well represented on the whole by the preceding formula. It is plain, however, that even 40 years is by much too short a period to give with accuracy the mean temperature of any given day. The following Table contains the mean temperature of each day of the year, founded on Mr Adie's observations.

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* When the temperature of February and March was the same, as in 1807, then one-half is the proportion for each.

Table showing the Mean Temperature of every day of the Year, at Edinburgh, from an Average of 40 Years' observations.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°	°	°
1	36·1	37·2	39·1	42·5	48·5	53·6	57·1	58·4	56·0	51·2	45·1	39·7
2	35·2	37·2	39·2	43·1	47·9	54·5	57·2	58·3	56·9	50·9	44·9	39·4
3	36·0	37·5	40·0	42·4	47·9	53·9	57·3	57·6	55·6	51·1	43·4	39·2
4	37·5	36·9	38·9	42·5	48·1	54·2	58·2	58·0	55·2	50·4	41·7	39·1
5	36·7	37·2	38·4	43·5	48·6	54·1	58·3	57·6	54·7	49·8	42·1	38·5
6	36·4	36·6	38·4	43·5	47·9	54·3	57·7	58·2	55·1	49·6	42·3	38·7
7	36·2	37·2	39·0	44·2	48·5	54·7	57·4	58·6	55·1	50·1	42·6	39·7
8	36·0	38·2	39·4	44·2	48·6	54·6	57·8	59·2	54·5	49·1	42·1	39·2
9	35·4	38·5	40·3	43·4	47·7	54·4	57·2	58·5	54·9	48·6	41·9	40·2
10	35·3	38·6	40·5	43·4	47·9	55·1	58·2	58·2	54·6	48·7	42·3	40·1
11	34·8	38·5	40·3	42·6	48·4	55·6	58·3	58·6	54·6	48·7	42·2	40·0
12	35·5	38·3	40·3	43·9	48·4	55·5	58·7	58·4	53·7	47·0	41·6	39·7
13	36·4	37·7	40·6	44·2	48·7	56·3	59·0	57·8	54·2	46·8	42·0	39·7
14	36·1	38·5	40·9	45·4	48·3	55·8	59·0	57·2	54·1	47·8	41·3	39·3
15	37·1	38·3	41·2	45·7	49·1	55·9	58·6	57·5	54·6	47·4	40·6	40·2
16	36·1	38·3	40·7	45·3	50·7	56·1	59·0	56·9	55·7	47·5	40·9	40·5
17	36·1	37·9	40·9	44·8	50·7	56·4	58·6	57·4	55·1	47·5	41·7	39·6
18	37·9	37·4	41·4	45·0	50·7	56·2	58·4	58·2	53·5	46·5	39·8	39·0
19	38·0	37·9	41·5	45·6	50·3	55·4	58·3	58·1	53·2	47·1	40·4	39·0
20	37·0	38·0	41·4	45·7	51·0	56·2	57·9	57·6	52·2	47·7	40·8	38·1
21	37·3	37·1	41·7	45·3	51·5	56·8	57·9	56·9	52·2	46·5	41·0	38·1
22	37·0	38·8	41·6	45·8	52·0	55·9	58·4	55·7	51·6	46·8	40·3	38·5
23	38·1	38·9	40·9	45·3	52·5	56·7	58·3	57·0	52·0	46·3	39·9	36·5
24	38·1	39·0	40·6	45·1	53·2	56·3	57·6	56·2	52·5	46 0	39·7	37·0
25	37·6	38·2	41·0	45·9	52·4	56·2	58·5	56·5	52·4	45·5	38·4	37·7
26	38·1	37·8	40·9	47·0	52·7	56·2	58·7	56·1	52·5	44·2	39·5	37·0
27	36·9	38·2	42·7	46·8	53·0	57·0	59·4	56·5	52·2	45·0	39·1	36·1
28	37·4	38·3	42·1	47·3	52·5	57·4	59·8	56·0	51·4	44·1	39·0	35·5
29	36·6	39·4	41·5	47·5	53·3	57·3	58·4	56·8	50·6	43·8	40·1	36·7
30	37·7	......	40·9	48·1	53·4	57·2	58·1	56·6	51·0	44·9	39·5	37·9
31	36·9	......	42·5	......	53·9	......	59·0	55·9	......	44·8	......	36·8

In this section are farther considered the inflections or "periodic anomalies" of the annual curve. When the normal curve deduced from the preceding equation (p. 295) is projected and compared with that which the projection of the daily temperatures produces, the latter is found to fluctuate considerably, and to pass in an irregular manner, sometimes above, and sometimes below, the geometric curve, which, however, fairly represents the totality of the observations.

We find, however, that there are deviations from the average or normal curve, which occur at certain seasons, and which do not appear to be entirely accidental. Several of these may be traced, for example, in each of the four decennial periods into which the series may be divided. These are called "periodic anomalies;" and their occurrence has previously been announced by De Humboldt, Arago, M. Quetelet, and others.

The most conspicuous of these anomalies occur in December, January, and February. An irregular elevation of temperature usually happens in the two middle weeks of December, followed early in January by an accession of cold, which accelerates the epoch of lowest temperature by at least a week, when we compare it with the geometric curve. This is again succeeded, in the latter part of January and beginning of February, by a period of comparative warmth. These anomalies seem to obtain at least over a great part of the west of Europe.

The author gives the name of "fluctuation" to the variation in the temperature of a given day of the year, from one year to another, arising from causes purely local and temporary, or, as we may call them, accidental. By applying the calculus of probability to the forty years' observations, we might assign the "probable uncertainty" in the determination of the temperature of any given day. The author has, however, confined himself to noting the highest and lowest mean temperature on a given day which has occurred during 40 years. These differences are sometimes very large. But they vary from one season to another according to a well-marked law. The "fluctuation" is greatest in January, when it amounts to 28° or 29°, and least in July, when it is only 16° or 17°. On the contrary, the *diurnal* range or difference of the maximum and minimum reading in 24 hours is least in December (9°·5), and greatest in June (18°).

Section Seventh.—The author concludes the paper with a comparison between the meteorological character of the seasons for fifty-six years, and the price of oats in the Edinburgh market for the same period, which was obligingly furnished to him by Mr Lawson. He has been quite unable to trace any connection between these classes of facts, and he recommends the subject to the consideration of those who are now occupied in considering the bearings of meteorology upon agriculture. When the seasons from 1795 to 1850 are arranged according to the price of oats, their order bears no intelligible relation to one or any of the previous classifications of those years according to warmth, moisture, or earliness. Thus much appears from the inquiry, that the attempt of Sir William Herschel to deduce the climatic influence of the solar spots from the market price of wheat, rests on a fallacious basis. It is only fair to add, that Sir William Herschel employed it with a reservation as to its reliability as a criterion of the temperature.

3. On the Mountain Limestone and Lower Carboniferous Rocks of the Fifeshire Coast. By the Rev. Thomas Brown. Communicated by Dr Allman.

The writer stated that this paper was the result of observations made while staying at the sea-coast for a few weeks in autumn. Near Ardross a bed of limestone had been discovered, with peculiar fossils, which promised geological results of some interest. To determine its stratigraphical position, it was necessary to reduce to order a portion of the coast, hitherto held to be in a state of hopeless confusion. This led to fuller inquiries, till the rocks underlying the coal-field had been examined from Burntisland to St Andrews.

Section I. A general description of the rocks was given, as seen along the shore, accompanied by a section in which they were laid down to scale.

Section II. Two classes of trap-rocks were referred to, viz.—1. The contemporaneous and interstratified; 2. The intrusive—this term being designedly used as expressing no opinion in regard to their origin, merely that the surrounding strata had been fractured, and through these fractures the traps in question had come into their present position. No proof had presented itself that these intrusive traps had exerted an upheaving agency, except perhaps at one point, and there only to a small extent.

Section III. The Mountain Limestone was described as consisting of three parts, viz.—

1. The six upper limestones, A to F. These, with their intercalated strata, immediately underlie the coal-fields. They are marine, and to them the term Mountain Limestone has usually been restricted. Their fossils were described.—Of crustaceans, there were one species of Trilobite, one of Eurypterus, one of Gampsonyx, (a genus not hitherto found in Britain), and two of Dithyrocaris, both, it is believed, new. Of fish, besides Rhyzodus, Holoptychius, &c.

there were two new species, a Cochliodus and a Ctenacanthus. The plates also of a tuberculated fish, belonging either to Pterichthys or some allied genus, were exhibited, proving that this great class had passed far up into the carboniferous system.

2. Estuarine strata, between F and L. These comprise the well-known Burntisland limestones, corresponding with beds west of Pittenweem.

One remarkable jaw of a pycnodont fish was exhibited from this part of the series near Kilwinning. Only one example of this class of fish-remains had previously occurred in the whole Palæozoic system—a small jaw found near Leeds.

3. The limestone L, the line of Lower Encrinites. This occurs east of Pittenweem, at Crail and St Andrews. The fossils were described similar as a whole to those of the beds A F.

Forty species of fossil shells occurring in these rocks were enumerated, only twelve of which are given in Professor Nicol's list of Scottish fossils. Among those here added, were *Sanguinolites tricostatus*, *Chemnitzia gracilis*, *Murchisonia trilineata*, &c. &c.

Section IV. Lower Carboniferous. This great underlying series was described in its leading features, especially—1. The Myalina beds—limestones composed of a single bivalve allied to Unio. 2. The deep-sea character of the fossils found at different levels, species of Orthoceras, Natica, Lingula, &c. 3. A limestone charged with great abundance of a new annelid, a species of Spirorbis, beautifully curved in a serpentine form.

Section V. Results. The two groups.

The writer explained that he had been led to deviate from the usually received classification of these rocks. Taking the upper portion of what Mr Maclaren terms the calciferous sandstones down as far as the bed L, and adding these to the upper zone, usually called the Mountain Limestone, two well-marked groups would be formed, and a well-defined line of division obtained.

1. *The Mountain Limestone.* The bed L, containing the same fossils with the six upper limestones, must (notwithstanding the intervening Estuarine beds) be classed along with them, and forms the base line of the upper group. The whole strata, from A to L, are approximately about 1000 feet in thickness. The limit upwards was not examined. The fossils all belong to the Mountain Limestone, and are extremely characteristic.

2. The underlying group, the Lower Carboniferous, is characterised by—1. The great Myalina beds. 2. The relative abundance of Cyclopteris; the Sphenopteris being the specially characteristic plant of the upper group. 3. The circumstance that the carboniferous fauna occurs only in an incipient state. The few species of Orthoceras, Aviculo-pecten, &c., which do occur, are of a carboniferous character, and prove the presence of deep-sea conditions; but all that specially marks the Mountain Limestone fauna (the Encrinites, Corals, Brachiopods) are either absent, or occur very scantily.

It would thus appear, that in this great series, which exhibits with singular clearness the development of the carboniferous epoch, the bed L marks the point of time when the Mountain Limestone fauna in its full strength came into view, while the lower carboniferous shows the same fauna in an incipient state. The latter may be studied with singular advantage on these shores, especially from Fife Ness to beyond Kingbarns.

The following Donations to the Library were announced:—

Memoires de la Société des Sciences Naturelles de Neuchatel. Tome IV. 1859. 4to.—*From the Society.*

Nederlandsch Kruidkundig Archief. Vol. IV., Part IV. 1859. 8vo.

Gelehrte Anzeigen. Band XLVIII. Munich. 1859. 4to.—*From the Royal Bavarian Academy.*

Jahrbuch des Kaiserlich, Königlichen Geologischen Reichsanstalt. Nos. 1 and 2. 1859. 8vo.—*From the Institute.*

Silliman's American Journal of Science and Arts. No. 85. January, 1860. 8vo.—*From the Editors.*

Atti dell' I. R. Istituto Lombardo di Scienze, Lettere, ed Arti. Vol. I. Fasc. 15 and 16. Milan. 1859.—*From the Institute.*

Memoire dell' I. R. Istituto Lombardo di Scienze, Lettere ed Arti. Vol. VIII. Fasc. 1. Milan. 1859.—*From the Institute.*

Ansprache Gehalten am Schlusse des Ersten Decenniums der Kaiserlich Königlichen Geologischen Reichsanstalt in Wien. Von W. Haidinger. 1859. 8vo.—*From the Institute.*

Die Fossilen Mollusken des Tertiær-Bekens von Wien. Von Dr Moritz Höres. Band II.—*From the Same.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Nos. 25 and 26. 1859-1860.—*From the Academy.*

Journal of the Asiatic Society of Bengal. No. 4. 1859. 8vo.—*From the Society.*

Quarterly Journal of the Geological Society. Nos. 60* and 61. 1860. 8vo.—*From the Society.*

Preisschriften gekrönt und herausgegeben von der Fürstlich Jablonowskischen Gesellschaft zu Leipzig. No. 7. 1859. 8vo. —*From the Society.*

Erinnerungen an Johann Georg von Lori. Von Dr Georg T. von Rudhart. Munich. 1859. 4to.—*From the Royal Bavarian Academy.*

The Journal of Agriculture and Transactions of the Highland and Agricultural Society of Scotland. No. 68. March, 1860. 8vo.—*From the Society.*

Journal of the Statistical Society of London. Vol. XXIII. Part I. March, 1860. 8vo.—*From the Society.*

The Australian and Californian Gold Discoveries, and their Probable Consequences. By Patrick James Stirling, F.R.S.E. Edinburgh, 1853. 8vo.—*From the Author.*

Harmonies of Political Economy. By Frédéric Bastiat. Translated from the French, by Patrick James Stirling, F.R.S.E. London, 1860. 8vo.—*From the Translator.*

Monday, 19th March 1860.

Dr CHRISTISON, Vice-President, in the Chair.

The following Communications were read:—

1. On an Apprehended Depreciation of Money, arising from New Supplies of Gold. By Patrick James Stirling, F.R.S.E.

The annual production of gold, in Europe, America, and Northern Asia, at the beginning of the present century, which was estimated by Baron Humboldt in round numbers at something over two and a half millions sterling, continued at about the same rate until additions began to be received from the renewed working of the Russian mines. These additions, which, for the period intervening between 1810 and 1822, are estimated by M. Michel Chevalier not to have exceeded in all one million and a half, gradually increased, until in 1847 they amounted to upwards of four millions per annum.

In the end of 1847, auriferous deposits of unequalled richness were discovered in California. In the succeeding year, about one million was received from this new source. Next year, the supply from the same source increased to four millions; in 1850, to twelve millions; and in 1857, to fifteen and a half millions sterling.

In February 1851, rich gold-fields were discovered in the territory of New South Wales; and in the August following still richer, and apparently inexhaustible, deposits were found in the Province of Victoria. In 1857, the annual produce of that province alone amounted to nearly eleven millions.

Thus, the total annual supply of gold, which at the beginning of the century, and for several years afterwards, did not much exceed two and a half millions, has now come to average about thirty-seven millions sterling.

The entire stock of gold in Europe and America, which was estimated at the beginning of this century at 354 millions sterling, is supposed in 1848 to have amounted to about 560 millions. America, in the 356 years which intervened between the memorable voyage of Columbus and the first discovery of gold on the Sacramento, had furnished of this quantity about 400 millions. In the twelve years from 1848 to 1860, the additions made to the stock amount to no less a sum (assuming the rate of yield of 1858 to have been continued in 1859) than 280 millions,—equal to one-half of the previously existing stock. In other words, one year's supply at present is nearly equal to one-tenth of the entire American supply for three centuries and a half.

When the produce of the Russian mines had reached four millions per annum, the late Sir R. Peel expressed an apprehension that so unusual a supply might create an action on general prices; and it is not to be wondered at that the vastly increased supplies of the last twelve years should have given rise to inquiry and controversy.

In France, the question of probable depreciation was felt to be more urgent and pressing than with us, from the circumstance that the Government of that country has persisted, in defiance of all sound principle, in maintaining a double standard of money, which we had long before got rid of. The silver coins of France, as had been predicted by M. Chevalier, began soon to disappear, and have since been exported, it is believed, to the amount of not less than sixty millions sterling, equal to one-half of what was supposed to be the entire French metallic circulation.

With us the question was, whether the new and greatly enlarged supplies of that metal, which since 1816 has formed the sole standard of our money—the universal medium of exchange, the common measure of commerce, in relation to which all pecuniary contracts are adjusted, and the value of all commodities estimated—a metal, too, (unlike silver) found in a comparatively pure state, and produced at a much less expense of labour and capital,—whether these supplies, if continued, as they seemed likely to be, would produce a depreciation of money, or, what is the same thing, a universal rise in the money value of labour and commodities, affecting in this way all contracts having reference to the future, and the purchasing power of fixed incomes.

Such a disturbance of the relations of property, it was remembered, had already occurred in our history. Three centuries ago, silver was the universal standard of money in Europe. Before the discovery of the rich mines of Potosi, and the introduction of Medina's process for separating silver from its ores by amalgamation with mercury, wheat in England was sold for 6s. 8d. a quarter; beef at 1d. a pound; ale at 1d. a gallon; and claret at 3d. a quart. The wages of a mason or carpenter were 4d. a day, and of a day-labourer 2d.; while a clergyman received L.5 a year, and an Oxford scholar 10d. a week. After these discoveries, and as the direct consequence of them, wages and general prices—not in England alone, but in France, in Spain, and generally over Europe—were quadrupled, and continued at the higher level ever afterwards. This remarkable phenomenon occurred about the year 1572. There was no war, or commercial disturbance, or other accidental circumstance to account for it. The coinage had been reformed twenty years before, and brought to very nearly our present standard, and there was neither dearth nor scarcity in the land; for the old chronicler tells us, "there was no want to him who wanted not money."* The value of labour and commodities appeared to have universally risen; but in reality it was the value of money which had fallen. The change was not in the things valued, but in the measure of value.

The wise councillors of Queen Elizabeth had not shut their eyes to the changes which were then impending, and their political and

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* True Relation of the most Remarkable Dearths, &c.

social consequences. The revenues of the Universities of Oxford and Cambridge, and of the Colleges of Eton and Winchester, arising principally from land, were anciently payable in money. The Lord Treasurer Burleigh, and other far-seeing men of that day, became sensible of the great diminution of the value of money which was about to be the consequence of the increased American supplies of silver, and to elude the effect of the impending depreciation, they had an act of Parliament passed, by which it was enacted, that in all future leases to be granted by the several colleges, one third part at least of the old rent should be reserved in corn, and should be converted into money each year, according to the average market-prices of grain. The money arising from this corn-rent, although originally but a third of the whole, is now worth double the other two thirds; and thus, by the wise precautions and foresight of the great men of that time, were these venerable seats of learning prevented from falling into comparative poverty and decay.

The question which now presents itself for solution is this: Are the recent discoveries of gold (now the standard of our money), and the vast accessions now making to the previous stock of that metal, producing at present, or are they likely to produce hereafter, effects similar in kind, although, it may be, inferior in degree, to the effects produced in the sixteenth century by the discovery of the American mines, and the great subsequent fall in the cost of producing silver? Or, on the contrary, are the situation of the world, and the circumstances of society, now so totally different as to place us altogether beyond the danger of any such revolution in the relations of property as our ancestors experienced in the days of the Tudors?

This subject gave rise to much controversy in 1852, after the first accounts of the Australian discoveries had reached this country. On reviewing the arguments on both sides (of which the author gave a summary), many of those whose attention had been previously directed to the subject, both here and on the Continent, felt themselves constrained to conclude that the preponderance of probability (to say the least of it) was on the side of those who maintained the likelihood of an ultimate general rise of wages and prices in Europe.

Of course, at that early period, all reasonings with reference to the future were, and could only be, conjectural, But judging from the past, and the effects formerly produced by the American supplies of silver, it was concluded that if the Australian and Californian production of gold were continued at anything like the rate it then promised, we should sooner or later witness the following among other striking effects, viz.—(1.) A marked and sudden rise of wages and prices in the gold-producing countries themselves ; (2.) A general and sustained rise, to a greater or less extent, of wages and prices in Great Britain, the United States, and other countries which employ gold as the exclusive standard of their money ; (3.) In countries, like France, which maintain a double standard of gold and silver (that is to say, where both metals are equally *legal tender*, and interchangeable, in certain fixed proportions), a continued disappearance of silver, and the gradual substitution of gold, followed by a rise of wages and prices in such countries ; (4.) A great and unusual impetus given to trade in all departments, and a marked increase of exports and imports ; (5.) No direct effect on the rate of interest, but a felt diminution in the purchasing power of fixed pecuniary incomes ; (*Lastly*) It was pointed out that these anticipated changes would probably be more or less retarded by the time necessary for the displacement of silver, and that the tendency to dearness would in some degree be counteracted by increased facilities of communication, improvements in agriculture, improved machinery, and the discovery and adoption of cheaper processes in manufactures.

Whether any or all of these anticipated results have as yet actually exhibited themselves, has given rise to much difference of opinion. Ten years are perhaps too short a period to enable us to come to a decided conclusion ; and within the last ten years several events have occurred to render the problem more complex, and its solution, for the present, more difficult ;—among others, the unusual drain of silver to the East, the displacement of silver in France, the demonetization of that metal in Holland and in our own East Indian possessions,—above all, the free-trade legislation inaugurated by Sir R. Peel, and the commercial and monetary crisis of 1857. From 1851 to 1857 the rise of wages and prices had been continuous. After the crisis a reaction took place, from the effects of which we are only now recovering, although it is believed that, in all departments of trade and industry, wages and prices are higher now (1860) than they were anterior to the Australian discoveries.

On the *first* of the probable effects which have been indicated, it is unnecessary to enlarge—the rise of prices in the gold-producing countries was marked and immediate. In California, the prices which prevailed in 1848 and 1849 were fabulous; and in Australia the rise of prices in 1851 was equally striking. From facts so exceptional no sound inference can be drawn.

A more difficult, and to us a more interesting and important subject of inquiry, is the action of the new gold supplies here at home—in the gold-receiving countries.

The price of grain, although the best available basis for instituting a comparison of prices from century to century, is perhaps the very worst on which to found such a comparison from year to year, or even for a period extending over a limited number of years. We may notice it, however, for what it is worth, during the period we are considering. Taking the average price of wheat in England for the "farmers' years," ending at Michaelmas, as given by Mr Willich, the Actuary of the Tithe Commutation Commissioners, the prices of the last eight years ended Michaelmas 1859, exceed those of the previous eight years, ended Michaelmas 1851, by nearly 12 per cent.

In provisions and butchers' meat, the rise in the London markets (as in those of Paris) has been continuous and progressive, exceeding at present the average prices of 1851 by from 20 to 30 per cent.

In colonial and tropical produce, tea, sugar, coffee, tobacco, silk, and cotton, there has likewise been an advance, although not to so great an extent; while in most of the materials of our manufactures—flax, timber, wool, and especially in metals, tallow, and some kinds of oils and dye-stuffs—there was a general and progressive rise, until the prices of 1857 exceeded those of 1851 by from 30 to 60 per cent. Consequent on the crisis of 1857 there was a sudden fall, but in very few instances to nearly so low a range of prices as prevailed in 1851; while since 1858 there has again been in most articles a continuous rise—in some instances to the extent of from 40 to 50 per cent. over the prices of 1851.

In July 1853, Mr Newmarch, in his able brochure "On the New Supplies of Gold," gave a list of the prices of 38 leading articles from the London Prices Current, selected impartially for the purpose of showing, that while many of the articles quoted had advanced in price, several of them, and these of great importance, such as sugar, tobacco, cotton, and silk, had either declined or remained stationary. I have since then kept a copy of this list, with blank columns, in which I have continued to fill in the prices every quarter from the same Price Current, in the same way as had been done for the preceding two years and a half. The result brought out in this way is, that, in the face of greatly enlarged production, and constantly increasing importations, with one or two exceptions *all* the 38 articles inserted have risen in price—most of them very materially, and many of them continuously and progressively, though, as might be expected, the constantly advancing tide has in the majority of instances been marked by fluctuations, exhibited most prominently after the crisis of 1857.

Now, this rise of prices during the last nine years (for the list begins in January 1851, and ends in January 1860) would be a serious look-out, especially for the working classes, were it not accompanied, as it appears to have been, by a simultaneous and corresponding advance in the money wages of all kinds of labour, both agricultural and manufacturing, skilled and unskilled.

Communications from eminent agriculturists represent the wages both of farm-servants and of day-labourers as having risen since 1850 fully 25 per cent. In Edinburgh, masons' wages, which in 1852 were 20s. per week of sixty hours, are now 5d. per hour, equal to 25s. a week, or an advance of 25 per cent. Joiners' wages, which in 1852 were 18s., are now 23s., or 27 per cent. higher. Upholsterers, then 19s., are now 23s., or 21 per cent. higher.

From an important paper, "On the Money Rate of Wages in Glasgow and the West of Scotland," communicated by Dr Strang to the Cheltenham Meeting of the British Association in 1856, and founded on actual returns, it appears that the increase of wages in 1856 over the rates of 1850–51 had been, in the case of masons, carpenters, and joiners, 20 per cent.; of unskilled labourers in the building trades, 48 per cent.; of engineers, 17 per cent.; of quarriers, 30 per cent.; of cotton-spinners, 25 per cent.; of power-loom weavers, 15 per cent. In a subsequent paper, communicated by the same gentleman to the meeting of the British Association at Leeds in 1858, he states, as the result of his more recent inquiries, that although the rate of wages in 1858 was lower than in 1856, it was still higher than in 1851. In a Report on the Statistics of Glasgow for 1859, Dr Strang states that "the wages of labour, now given for a week of diminished hours, have greatly advanced, and are still on the rise; and when measured either in grain or in time, are generally higher than they ever were known to be."

The price of labour, especially of unskilled labour, is perhaps the surest test we can apply in judging of the comparative value of money at different periods.

That the rate of wages in the gold-producing countries should be acted on directly by the conditions under which the material of money is produced is not to be wondered at. The manner in which it acts on wages in Europe is not so obvious, but is by no means incapable of explanation. The price of labour is subject to the law of supply and demand, depending as it does on the numbers of the working population on the one hand, compared with the fund for the payment of wages on the other. If the gold discoveries, then, have caused unusual emigration, and so thinned the labour-market, while the equally unprecedented impetus given to trade, and attributable in part at least to these discoveries, has greatly increased the fund for the employment of labour, we discover a twofold cause for the rise which has taken place.

The average annual emigration from the United Kingdom, which for the five years ending 1846 had been 87,850, increased for the five years ending 1855 to 299,300.

The increase of the fund for the payment of wages may be judged of from the unparalleled extension of trade which has taken place since 1848. The real value of the exports of British produce, which in 1848 amounted to L.52,849,445, rose in 1857 to L.122,066,107, and, according to the Board of Trade tables recently issued, after falling in 1858 to L.116,608,756, reached in 1859 the absolutely unprecedented sum of L.130,440,427. No doubt much of this increase must be set down to the credit of our recent free-trade legislation; but a considerable proportion of the increase, especially since 1851, consists of additions to our trade with the gold-producing countries. Our exports to Australia, for example, which in 1848 amounted to less than one million and a half, had increased in 1859 to eleven millions and a quarter.

The coinage of gold in Great Britain, France, and the United States, has kept pace with the increased supplies of that metal. In this country, between 1848 and the end of 1856, we had coined gold to the value of fifty millions. In the United States, during the same period, the gold coinage amounted to the value of 68½ millions sterling; while in France, between 1850 and the end of 1858, it amounted to a sum equal to L.129,587,735 sterling. The importance of these figures will be appreciated when it is remembered that during the forty-five years which preceded 1848, France had coined gold at the rate of less than one million sterling per annum—less than is now issued each year by the Royal Mint of Sydney—and that the coinage of England during the seven years preceding 1850 amounted to little more than four millions per annum.

Assuming that these unprecedented additions to the stock of gold in circulation must sooner or later depreciate the value of money, we should naturally proceed next to inquire what the effects of such a depreciation are likely to be on the condition of different classes of society; in what manner, and to what extent, it may affect the interest of landlords and tenants, debtors and creditors, labourers and capitalists, annuitants, shareholders, stipendiaries, families prospectively dependent on policies of life assurance, and others having an interest not only in the present but the future value of money; what precautions such impending changes should suggest with reference to investments; what legislative measures, if any, they invite; what are likely to be their effects in lightening the pressure of our public debt, or increasing the exactions of Government for the current service of the State; whether, and to what extent, these changes are likely to be modified or retarded by countervailing causes; and how far the tendency to dearness caused by a depreciation of money may not be compensated by the tendency to cheapness which improvements in agriculture, in manufactures, and in the various departments of industry and production, never fail to carry in their train. These are inquiries of great interest and importance, but they open up too wide a field to be entered on at present. The more immediate question is—Are there indications that a depreciation of money is imminent, or has it already actually begun?

2. On the Chronology of the Trap-Rocks of Scotland. By Archibald Geikie, F.G.S., of the Geological Survey of Great Britain. Communicated by Robert Chambers, Esq.

The first part of this paper contained a review of the existing nomenclature of trappean-rocks, and the following arrangement was given as that which the author had found to be most useful for practice in the field:—1*st*, Ash and volcanic conglomerate. 2*d*, Interbedded augitic traps (greenstones and basalts). 3*d*, Interbedded felspathic traps (felstones, porphyries). 4*th*, Intrusive augitic traps. *5th*, Intrusive felspathic traps. By adopting a different colour for each of these classes, the general relations of an intricate trappean district could be shown at a glance.

Although it was well known that the trap-rocks of Scotland belonged to several distinct geological epochs, much still remained to be done, both in determining their exact age and in working out the details of their structure. The author had been engaged in this subject for several years, and the present paper was intended as the first of a series elucidatory of Scottish trappean geology.

Silurian.—It was remarked that, both in the Lower Silurian grits of the Lammermuirs, and in the Upper Silurian grits of the Pentlands, there is an abundance of felspathic matter, pointing to the existence of felspathic rocks, either then or previously ejected. The Lammermuir chain is likewise traversed by innumerable felstone dykes, probably produced at the time of the folding of the Silurians. At Reston, in Berwickshire, beds of ash occur in the Lower Silurian.

Old Red Sandstone.—The author referred to a previous paper (read before the Geological Society) in which he had shown that the Old Red Sandstone of the south of Scotland consists of two distinct portions—one conformable with the Upper Silurian, and traversed by the same foldings and dykes; the other lying utterly unconformably, both on the Upper Silurian and the Lower Old Red. The igneous rocks of the older series probably occur in the Sidlaw Hills; those of the newer series are well displayed in the Pentlands, the structure of which was detailed.

Carboniferous.—The great abundance, the variety of character, the local nature, and the great vertical range of the carboniferous traps of central Scotland, was shown by a detailed sketch of the geology of the Lothians. The range of hilly ground between Bathgate and Linlithgow was pointed out as an eminently characteristic district. A careful survey had shown that no well-marked zone of the 6000 or 8000 feet of carboniferous strata in some part of the Lothians was without traces of contemporaneous igneous eruptions.

Oolitic.—The structure of Skye and Raasay was described. These islands (when examined along a section from Dun Can, in Raasay, to Dunvegan, in Skye) consist of successive sheets of greenstone, with intercalated seams of estuary limestone, shell, sandstone, and coal, belonging to the Oolitic series.

Secondary, or Tertiary.—Allusion was made to the Tertiary basalts of Mull, and to the possibility of there being other igneous rocks of that age on the mainland. A section of Arthur's Seat was exhibited, showing a series of volcanic eruptions, resting quite unconformably upon some of Carboniferous date. This later group must be greatly posterior to that below; and the author collected evidence to show that it may be regarded as later Secondary, or older Tertiary.

Letter from the Rev. Dr Livingstone, F.R.S., to Dr Lyon Playfair, C.B.

River Shire, 28*th Oct.* 1859.

My dear Dr Playfair,—We left England in April 1858, and up to this time we have not received a single private letter from home. This saves me the trouble of apologising to any of my friends whom I have neglected. So here goes into the middle of things. We have just traced this river up to its point of emergence from the hitherto undiscovered Lake of Nyassa or Nyinyessi. This discovery is of more importance than at first sight appears, for it opens a cotton-field superior, I imagine, to the American, inasmuch as there are no frosts to endanger or cut off the crops; and instead of the unmerciful toil required to raise the staple there, one sowing of foreign, probably American seed, introduced into several parts by the natives themselves, serves for three years' crops. Even when burned down, the plants spring up fresh again. It may have disadvantages to counterbalance these points in its favour, but of these I am at present ignorant. There is a good day's channel from the sea at *Kongone* harbour up to Murchison's Cataracts in lat. 15° 55′ south. We have then only 33 miles of cataracts, past which a common road could easily be made—and the Shire itself is again navigable right into Nyassa in lat. 14° 55′ south. Above the cataracts the land is arranged into terraces east of the river. The lower or Shire Valley is about 1200 feet high, and exactly like the valley of the Nile at Cairo, only a little broader. The second terrace is over 2000 feet and three or four miles broad; the third over 3000, or about equal to Table Mountain at the Cape (long spoken of as the highest in South Africa). We travelled in the hottest season of the year, or that called in the West the "smokes," when, from the burning of tens of thousands of acres of tall grass, the atmosphere becomes like a partial cloud or fog, but insufferably hot. When we ascended the second terrace, the air felt delightfully cool, and on the third it was perfect, neither too cold nor too hot. All these terraces are wonderfully well supplied with running rills of deliciously cool water; and cotton of the indigenous variety (which feels more like wool than cotton, and requires to be cropped annually) is cultivated to a very considerable extent. On the last terrace rises Mount Zomba, which we ascended, and found to be in round numbers 7000 to 8000 feet high. Here it was cold; but there is cultivation and a fine stream in a large valley on its top. It has a base of 20 or 30 miles. We have thus differences of climate within a few miles of each other. This for keeping Europeans well. Then we are indulging the pleasant belief, from which you may deduct a percentage, that we can cure the fever, even in the lowlands, quickly and without loss of strength to the patient. We shall beat Holloway yet! only we tell every one what our pills are made of. It is the system followed when I was alone, and adverted to at the end of my book. We have, thank God, not lost a man yet, and gave the quinine a fair trial. It never prevented an attack. We have given it up now. We took it after our wine was done, partly for the sake of the dram, and partly to prevent you folks blaming us after we were dead.

Well, beyond Zomba the land between Shire and the two lakes of Shirwa, or, as its name really is, Tamandua, and Nyassa or Nyinyessi, contracts into a narrow isthmus, and all the slave trade from the interior must cross, in order to get past the lakes without embarking on either. We met a large slaving party there. I think they are what people suppose to be Arabs at the Angoxia river, but they could not speak Arabic. They were the most blackguard-looking set I ever saw. When they understood we were English, they made off by night, probably with the same opinion of us as we had of them. They had an immense number of slaves. A station for lawful commerce here would root out that traffic.

The lake at its southern end seemed eight or ten miles broad—had a heavy swell on it though there was no wind—and it must be large to give off the Shire constantly (80 to 120 yards wide, 2 fathoms deep, and 2½ knot current) the whole year, with a variation in the river of about 2 feet from the wet to the dry season.

We should have explored it, but had left Mr Macgregor Laird's vessel in a sinking state. Funnel, furnace, deck, and bottom, all became honeycombed simultaneously. . . .

DAVID LIVINGSTONE.

The following Donations to the Library were announced:—

Quarterly Return of Births, Deaths, and Marriages registered in Scotland—Quarter ending 31st December 1859. 8vo.—*From the Registrar-General.*

Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences. Nos. 9, 10. 4to.—*From the Academy.*

Monthly Notices of Astronomical Society. Vol. XX., No. 4. 8vo. —*From the Society.*

List of Fellows of the Royal Astronomical Society, February 10, 1860. 8vo.—*From the same.*

Journal of Proceedings of Linnean Society. Supplement to Vol. IV.—Botany. 8vo.—*From the Society.*

Monthly Return of Births, Deaths, and Marriages registered in Scotland—January and February 1860. 8vo.—*From the Registrar-General.*

Answer to Sir David Brewster's Reply to Messrs Stevenson's Pamphlet on Sir David Brewster's Memorial to the Treasury. By D. and T. Stevenson. Edinburgh, 1860. 8vo.—*From the Authors.*

Descriptions of New Palæozoic Fossils from the Western States. By J. H. M'Chesney. Chicago, 1859. 8vo.—*From the Author.*

Proceedings of the Royal Geographical Society of London. Vol. IV., Part I. 1860. 8vo.—*From the Society.*

Maury's Sailing Directions. 2 vols. 1858. 4to.—*From the United States Government.*

Maury's Wind and Current Charts.—*From the same.*

Part of a Panoramic View of Kashmir Mountains. Sketched by T. G. Montgomerie, Bengal Engineers, to illustrate G. T. Survey of Kashmir.—*From Prof. C. P. Smyth.*

Fac-simile of an Ancient Manuscript on Parchment in the Record Office, which has been copied and printed by Photo-Zincography at the Ordnance Survey Office.—*From Colonel James.*

Monday, 2d *April* 1860.

Lord NEAVES, Vice-President, in the Chair.

The following communications were read:—

1. On the Solidification of Limes and Cements. By George Robertson, C.E.

The paper was deduced from a series of experiments, made on the London Dock Works with blue lias and Dorking limes; and at Leith Docks with the limes in the neighbourhood of Edinburgh, and with cements both natural and artificial. A short account was first given of the nature of the experiments at the London Docks, with the points investigated. A longer and more professional account of these is to be found in the Transactions of the Institution of Civil Engineers for 1857–58.

The solidification of lime was considered under two general heads.

1*st*, That of ordinary limes and plasters, in which the action of setting was proved to be at first entirely of a mechanical nature, when slaked lime is used for mortar; when quick lime is used, though the set is hastened by the chemical act of hydration, it is still, in practice, caused by mechanical causes,—the set in both cases being due to the absorption into the pores of the lime of a great part of the water of mixture, accompanied by a contraction in the bulk of the mortar. After the first set, induration increases; at first from the evaporation of some of the water of mixture, and afterwards from the absorption of carbonic acid from the atmosphere. The author found, that when limestones were cemented together, the mortar absorbed carbonic acid from the stones themselves, somewhat in proportion to the quantity in the limestone. He also found that the presence of silica in chemical combination with lime deadened the desire of the lime for carbonic acid. In hydraulic lime, therefore, which owes the permanence of its set to silica in combination with it, the induration due to carbonic acid is less than in ordinary and purer limes.

The second division of the subject comprised all limes and cements which set *permanently* hard under water. In this case, though the first set is caused by the same absorption of the water of mixture as in ordinary limes, the permanent hardness cannot, evidently, result from desiccation, either from absorption or evaporation. A chemical combination between the lime and some agent capable of resisting the softening action of water is necessary. Silica was proved to be the only substance found naturally in limes, which was capable of furnishing this protection; and *it* was only useful when present in combination with alumina, as clay, in a hydrated form. Double silicates of lime and alumina form harder mortars than silicate of lime alone. Iron, manganese, magnesia, and alumina by itself, were shown to have no chemical effect in setting lime under water, though they furnish a kind of temporary mechanical protection from solubility. The iron in pozzuolana may even be withdrawn by an acid, without to any extent injuring the hydraulic properties of the earth. The author believed that in properly calcined hydraulic lime no union between the silica and lime took place in the kiln, but only on the completion of a hydrate by slaking, and then only when surplus water was present. This theory was founded on experiments upon the adhesion of mortar at different stages of setting, silicate of lime having little power of cementation. The degree of adhesion, marked tolerably exactly the progress of the silicification of the lime. Experiments on the quantity of silica derived from Portland cement, digested in a weak acid, both when fresh from the kiln and after having been set for six days, gave still more direct evidence of the truth of this theory, which was proved by the author to be of great practical importance in the application of limes. It was stated that, oxalic acid had been ascertained to be capable of setting limes permanently hard under water, when mixed with the water used in slaking; but the oxalate of lime does not possess the same flinty hardness as the silicate, and of course is much more expensive—at the present price of oxalic acid. The paper closed with some remarks on "cements," both natural and artificial; the properties of which, under the generic types of Roman and Portland cements, were shortly explained.

2. On Zinc-Methyl. By J. A. Wanklyn, Esq.

Considerable difficulties attend the preparation of zinc-methyl. Frankland, who discovered the body, obtained it by heating pure iodide of methyl and zinc enclosed in small glass tubes. Owing to the high temperature at which reaction takes place, much gas is formed; hence the operation must be confined to very small quantities of materials. .

No determination of the boiling-point, specific gravity, nor yet of the vapour density of zinc-methyl, was made by its discoverer; from which fact may be inferred how small was the product available for investigation.

Frankland* has recently endeavoured to improve the process of preparation. He has tried a modification similar to that which he had introduced for zinc-ethyl. He mixed ether with the iodide of methyl, and heated with zinc in his copper digester. By this means ready decomposition of the organic iodide was obtained, and very little gas was evolved; but subsequently it was found impossible to separate the ether from the zinc-methyl. By this process Frankland did not succeed in obtaining any pure zinc-methyl.

To meet this difficulty is the object aimed at by the author of the paper.

Instead of using ether to mix with iodide of methyl, the author uses either a strong solution of zinc-methyl in ether, or pure zinc-methyl; either of which he has found capable of rendering the action of zinc upon the organic iodide easy, and unaccompanied by much gaseous products. All his digestions he makes in glass tubes heated in the water-bath to 100° C. The strong solution of zinc-methyl was obtained, in the first instance, by digesting together ether, iodide of methyl, and zinc, and afterwards distilling. The distillate was then employed in a second operation in place of ether, and so a still stronger solution of zinc-methyl resulted.

By repeating the process zinc-methyl was finally obtained in a state of tolerable purity. A single tube, which had undergone four digestions, furnished about half an ounce of product, which analysis showed to consist of zinc-methyl nearly pure.

A determination of the vapour density of zinc-methyl made by Gay Lussac's method gave 3·291. The calculated theoretical number is 3·299. Accordingly, the condensation of zinc-methyl corresponds to that of ether, and not to that of hydride of methyl—in this respect resembling zinc-ethyl.

In addition to the properties of zinc-methyl mentioned by Frank-

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* Annalen der Chemie u Pharmacie von Liebig, cxi. p. 62. Frankland.

land, viz. its extreme inflammability, its action upon water, &c., the author has observed that the body may be heated to 200° C. without decomposition. At 270° C. it begins to yield metallic zinc.

The boiling-point of zinc-methyl lies between 50° C. and 60° C., but the author reserves the accurate determination until he shall be in possession of several ounces of the pure body.

In one respect the author's observations do not accord with Frankland's; he has not been able to verify what has been advanced concerning the poisonous nature of zinc-methyl fumes.* Having performed more than a dozen distillations of the body, and having been much exposed to the fumes, he has not been able to mark any special effect upon his health. With regard to the disagreeable odour of the body, he has also to remark, that a mixture of zinc-methyl with much ether is more offensive than zinc-methyl pure, or containing only a little ether.

The author remarks, that considerations drawn from the state of condensation of the so-called organo-metallic bodies, lead to the conclusion that the metals are not the representatives of hydrogen. The formulæ of equal volumes of the following bodies reduced to a state of vapour are adduced as examples:—

Zinc-methyl. $\left.\begin{matrix}C_2\,H_3\\C_2\,H_3\end{matrix}\right\}Zn_2$; Zinc-ethyl. $\left.\begin{matrix}C_4\,H_5\\C_4\,H_5\end{matrix}\right\}Zn_2$; Mercury-methyl. $\left.\begin{matrix}C_2\,H_3\\C_2\,H_3\end{matrix}\right\}Hg_2$; Mercury-ethyl. $\left.\begin{matrix}C_4\,H_5\\C_4\,H_5\end{matrix}\right\}Hg_2$.

Distann-methyl. $\left.\begin{matrix}C_2\,H_3\\C_2\,H_3\\C_2\,H_3\\C_2\,H_3\end{matrix}\right\}Sn_2$; Distann-ethyl. $\left.\begin{matrix}C_4\,H_5\\C_4\,H_5\\C_4\,H_5\\C_4\,H_5\end{matrix}\right\}Sn_2$.

Hydride of methyl. $C_2\left.\begin{matrix}H_3\\H\end{matrix}\right\}$; Hydride of ethyl. $C_4\left.\begin{matrix}H_5\\H\end{matrix}\right\}$; Methyl-ether. $\left.\begin{matrix}C_2\,H_3\\C_2\,H_3\end{matrix}\right\}O_2$; Ethyl-ether. $\left.\begin{matrix}C_4\,H_5\\C_4\,H_5\end{matrix}\right\}O_2$.

From which it appears that there is twice as much methyl in the standard volume of zinc-methyl vapour as there is methyl in the standard volume of hydride of methyl. It appears, also, that Zn_2 in zinc-methyl represents O_2 in methyl ether. There is no organo-metallic compound known in which the metal has a condensation corresponding to that of hydrogen.

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* Liebig's Annalen der Chemie u Pharmacie, lxxi. p. 214. Frankland.

3. Notes of the Dissection of a Female Beaver. By John Cleland, M.D., Demonstrator of Anatomy, University of Edinburgh. Communicated by Dr Douglas Maclagan.*

In this paper the writer directed attention to the remarkably developed parotid glands of the beaver, which form a single large mass covering the whole front and sides of the neck, and cannot be separated from one another. He showed how the apparent disproportion between the anterior and posterior extremities of the beaver was increased by the way in which the parietes of the abdomen overhung the thighs, and the margin of the *panniculus carnosus* passed over the knees so as to include them in the muscular investment that enveloped the trunk.

The use of the horny development, called by zoologists an additional nail, on the second toe of the hind foot, was explained thus:—the toes, especially the first and second, are curved inwards for purposes connected with the animal's aquatic habits; and when it supports itself in its favourite posture on its hind legs and tail, these two toes lie with their outer sides downwards. The innermost is small, and bears none of the weight; but the second toe bears a considerable amount, and the tender matrix of the nail would be constantly pressed against the ground, were it not that the horny development is so shaped that, while it presents its under surface to the earth, the superior aspect fits in to the concavity of the claw above.

The dilatation of the *vena cava* for diving purposes was described, and the arrangement of the castor sacs.

The principal points with regard to the latter are as follows:—The rectum and genito-urinary aperture open into a common depression as in the male, and the oil glands and general form of the castor sacs resemble those of the male; but while in the male the necks of the castor sacs of opposite sides are united by a communication above the preputial opening—*i. e.*, between the prepuce and rectum—in the female they are united by a dilatation like a small third lobe, situated, not on the superior aspect of the genito-urinary aperture as in the male, but on the pubic aspect; and the clitoris appears on the anterior margin of the dilatation immediately inferior to the urethral orifice. The castor sacs and oil glands are invested by a muscular tunic, whose fibres, arising superiorly in connection

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* Published in full, with a plate, in the Edinburgh New Philosophical Journal, New Series, vol. xii. p. 14.

with the compressors of the rectum, pass round and are inserted on the inferior aspect of the sacs into a circular set of fibres which surround an uninvested space in the middle line, opposite the median dilatation. The round ligaments of the uterus end on this muscular tunic. The rectum is surrounded by a set of remarkably developed compressors.

4. On the Thyroid Gland in the Cetacea; with Observations on the Relations of the Thymus to the Thyroid in these and some other Mammals. By William Turner, M.B. (Lond.), Senior Demonstrator of Anatomy, University of Edinburgh. Communicated by Professor Goodsir.

The author, in the first instance, directed attention to the discrepant statements of various comparative anatomists respecting the thyroid gland in the Cetacea, quoting from the writings of John Hunter, Meckel, Cuvier, Carus, and Dr Martyn. He then related the result of his own dissections made on three specimens of the common porpoise (*Phocæna communis*), one being a fœtus, another a well grown male, the third an adult male. In each of these animals a well marked thyroid gland was found, lying on the anterior and lateral surfaces of the trachea at its upper end, and extending slightly upwards on each side over the outer surface of the cricoid cartilage. It presented no division into two lateral lobes, as described by Cuvier and Carus, but consisted of a single uniform mass extending across the middle line. In the adult animal, which was examined in the fresh state, the other specimens having been some time in spirits, the gland presented a dark purple tint, and a soft and somewhat succulent aspect. Both in the fœtus and well grown animal, the thymus gland was exceedingly well developed. A detailed description of the position and relations of this gland was then given, the long ascending processes which pass upwards, by the side of the great vessels, as far as the thyroid gland, being especially pointed out. These processes were intimately connected with the lateral portions of the thyroid by cellular tissue, but were not continuous with them.

The author next referred to Mr Simon's description of the thymus in the fœtal dolphin.

The microscopic characters of the thymus gland in the well-grown porpoise were then given. It was found to consist of small closely packed corpuscles, about the size of, or a little larger than, the red corpuscles of human blood—its structure, in fact, exactly corresponding with that which is familiar to us in the fœtal gland. Thus this animal gave us an additional illustration of the truth of the statement made by Haugsted and Simon, that the thymus is not merely a fœtal structure, but that it plays an important part in the animal economy for some time after birth.

The author considered that the close relation which was found in these porpoises between the thymus and thyroid glands, might be regarded as confirmatory of the view entertained by Professor Goodsir, that they are developed from a common structure.

He next described a dissection of the thymus and thyroid, which he had made in an adult male Hartebeest (*Bubalus Caama*). The thyroid in this animal was separated into two distinct lateral lobes, each lobe having connected with it a long slender glandular process, which passed down the sides and front of the trachea, behind the sternum, into the anterior mediastinum. These glandular processes exhibited microscopically the characters of the thymus, so that, both as regards structure and position, they must be regarded as constituting that gland.

The thymus and thyroid glands in the Nylghau (*Antilope picta*) were then described. The animal dissected was a magnificent specimen of an adult male, standing one foot above the recorded average height of the male. In it the thyroid was divided into two distinct lateral lobes, each lobe extending from the cricoid cartilage as far as the fourth tracheal ring. Situated on the anterior surface of the trachea, and on the crico-thyroid membrane between these thyroidean lobes, were scattered lobules of glandular tissue of a slightly reddish tint. These were not connected with the thyroid, but were lying in the cellular tissue between its lobes. Similar scattered lobules extended for some distance down the trachea, but about thirteen inches above the sternum they became aggregated together, so as to form two long lines of glandular tissue, which passed beneath the sternum into the anterior mediastinum. Structurally this gland presented the character of the thymus. It corresponded also to it in position. In addition to the proper gland structure, the microscope brought into view numerous three-sided prismatic crystals, resembling those of the triple phosphate, lying in and about the connective tissue of the gland.

From the evidence afforded by the dissection of the Hartebeest and Nylghau, the conclusion must be drawn that in these Antilopidæ the thymus is a permanent gland; for there could be no doubt but that both these animals had reached the adult period of life, and even acquired a considerable age,—their large size, and the worn appearance of the teeth rendered this sufficiently manifest. So far, then, as regards these animals, the thymus must be looked upon as possessing a more enduring function than has hitherto been ascribed to it in the economy,—not disappearing or altogether degenerating in the early period of extra-uterine life, but persisting even in the adult animal. The paper concluded by some remarks upon the thyroid and thymus glands in the human subject.

5. Notice on the Boring of the Pholadidæ. By Alexander Bryson, Esq., President of the Royal Physical Society.

In this communication the author referred to the various theories advanced to account for the boring of the Pholadidæ in rocks.

The first hypothesis, which supposes that the molluscs perforate by means of the rotation of the valves acting as augers, he disproved by exhibiting old individuals of the *Pholus crispata* with the dentated costæ as sharp as in any young specimen. That these animals bore by silicious particles secreted by the foot, as suggested by Mr Hancock, has been disproved by microscopic observation; and that currents of water set in motion by vibratile cilia, seemed also insufficient to account for the phenomenon.

Another theory supposes that an acid is secreted by the foot, capable of dissolving the rock.

This the author showed was not tenable, as the strongest Nordhausen sulphuric acid fails to dissolve aluminous shales and Silurian slates; and also that any such acid secretion would act more readily on the valves themselves. From many experiments on the cutting of hard silicious substances, the author found that the softer the substance was in which the cutting material was impacted, the greater the amount of the work done. He was thus led to the conclusion that the Pholadidæ bore with the strong muscular foot alone, and that they obtain the silica from the waves or the arenaceous rocks in which they are found; and hence there is no necessity for either an acid or silicious secretion. That the foot was the boring apparatus, and not the valves, he proved from a specimen of a Pholas hole in shale, where the pedal depression of the animal was distinctly seen.

He also exhibited a piece of glass bored to the depth of 1·50 of an inch, by means of the point of the finger and emery alone.

The following Gentlemen were balloted for, and elected Ordinary Fellows:—

George A. Jamieson, Esq., M.A.
Rev. **Leonard S. Orde.**
Patrick Dudgeon, Esq., of Cargen.

The following Donations to the Library were announced:—

Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences. Nos. 11, 12.—*From the Academy.*

Rectification of Logarithmic Errors in the Measurements of two Sections of the Meridional Arc of India. In a Letter to Professor Stokes, Sec. R.S. By Colonel Everest, F.R.S.—*From the Author.*

Reply to Messrs Stevenson's Pamphlet on Lighthouses. By Sir David Brewster, K.H., D.C.L., F.R.S.—*From the Author.*

Bulletin de la Société de Géographie. Quatrième Série. Tome XVIII. Paris, 1859. 8vo.—*From the Society.*

Observations Astronomiques faites à l'Observatoire de Genève, dans les Années 1853 et 1854. Par E. Plantamour. XIII^{e} et XIV^{e} Série. 1859. 4to.—*From the Author.*

Resumé Météorologique de l'Année 1858, pour Genève et le Grand St Bernard. Par E. Plantamour. Geneva, 1859. 8vo.—*From the Author.*

Uber die Natürliche Lage von Bern, von B. Studer. Bern, 1859. 4to.—*From the Author.*

Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Tome XV., Part 1st. Geneva, 1859. 4to.—*From the Society.*

Abhandlungen, herausgegeben von der Senckenbergischen Naturforschenden Gesellschaft. B. III., Part 1st. 1859. 4to.—*From the Society.*

Biographical Sketch of the late Dr George Wilson. By Professor Balfour.—*From the Author.*

Die Fortschritte der Physik im Jahre, 1857. Dargestellt von der physikalischen Gesellschaft zu Berlin. XIII. Jahrgang. Zweite Abtheilung.—*From the Society.*

Magnetical and Meteorological Observations made at the Honourable East India Company's Observatory, Bombay, in the year 1857, under the superintendence of Lieutenant E. F. T. Fergusson, I.N., F.R.A.S. Bombay, 1858.—*From the Government of India.*

Lithograph of the Fossil Trees discovered in the Quarry at Granton. —*Presented by Robert Allan, Esq., F.R.S.E.*

Tuesday, 17*th April* 1860.

THOMAS STEVENSON, Esq., Councillor, in the Chair.

The following Communications were read:—

1. On the Birds of Linlithgowshire. By Rev. John Duns, F.R.S.E., Torphichen.

The author, having referred to the value of carefully prepared reports on the ornithology of particular districts, characterised the physical features of that part of Linlithgowshire in which his observations had mainly been made, and showed that it is well fitted for the support of a comparatively large number of species of birds. He stated that the following list had been gradually formed as the result of observations spread over fifteen years. Most of the species named had come under his own notice; for a few he had been indebted to Thomas Durham Weir, Esq. of Boghead, an accurate observer. The classification followed is that which he had found most helpful to his own studies. Species seldom met with are printed in italics.

Order I.—Raptores.

Families.	Genera.	Species.
Falconidæ.	Milvus—	*M. Regalis.*
	Falco—	*F. æsalon*, F. tinnunculus.
	Accipiter—	A. nisus.
	Circus—	C. cyaneus.
Strigidæ.	Strix—	S. flammea, S. aluco, S. otus, *S. brachyotus.*

Order II.—Scansores.

Families.	Genera.	Species.
Cuculidæ.	Cuculus—	C. canorus.

ORDER III.—PASSORES.

Families.	Genera.	Species.
A. Fissirostres.		
CAPRIMULGIDÆ.	Caprimulgus	C. Europæus.
HIRUNDINIDÆ.	Hirundo	H. rustica, H. urbica, H. riparia.
	Cypselus	C. murarius.
HALCYONIDÆ.	Alcedo	A. ispida.
B. Tenuirostres.		
CERTHIADÆ.	Certhia	C. familiaris.
	Troglodytes	T. Europæus.
C. Dentirostres.		
TURDIDÆ.	Turdus	T. merula, T. torquatus, T. pilaris, T. viscivorus, T. musicus, T. iliacus.
	Cinclus	C. Europæus.
AMPELIDÆ.	Bombycilla	B. garrula.
LANIADÆ.	Lanius	L. excubitor.
SYLVIADÆ.	Sylvia	S. rubecula, S. hortensis, S. atricapilla, S. cinerea, S. phœnicurus, *S. locustella*, S. arundinacea, *S. phragmites.*
	Phillopneuste	Ph. sylvicola, Ph. trochilus.
	Regulus	R. auricapillus.
	Saxicola	S. œnanthe, S. rubetra, S. rubicola.
	Accentor	A. modularis.
	Parus	P. cæruleus, P. major, P. longicaudatus, P. ater.
	Motacilla	M. Yarrelli, M. boarula, M. flava (Budytes Rayi).
MUSCICAPIDÆ.	Muscicapa	M. grisola, *M. luctuoso.*
D. Conirostres.		
CORVIDÆ.	Corvus	C. corone, C. cornix, C. frugilegus, C. monedula.
	Garrulus	G. melanoleuca, G. glandarius.
STURNIDÆ.	Sturnus	S. vulgarus.
	Pastor	*P. roseus.*
FRINGILLIDÆ.	Pyrgita	P. domestica.
	Fringilla	F. montifringilla, F. cœlebs, *F. spinus*, F. carduelis, F. cannabina, F. linaria, F. flavirostris, *F. borealis.*
	Loxia	L. chloris, L. pyrrhula, *L. Europœa*, *L. coccothraustes.*
	Emberiza	E. citrinella, E. miliaria, E. nivalis, E. schœniculus.
	Alauda	A. arvensis, *A. arborea.*
	Anthus	A. pratensis, *A. arboreus.*

ORDER IV.—COLUMBÆ.

Families.	Genera.	Species.
COLUMBIDÆ.	Columba	C. palumbus.

ORDER V.—GALLINÆ.

Families.	Genera.	Species.
TETRAONIDÆ.	Tetrao	T. Scoticus, *T. tetrix*.
	Perdix	P. cinerea, *P. coturnix*.
PHASIANIDÆ.	Phasianus	Ph. Colchicus.

ORDER VI.—GRALLATORES.

Families.	Genera.	Species.
ARDEADÆ.	Ardea	A. cinerea.
	Botaurus	*B. stellaris*.
CHARADRIADÆ.	Charadrius	C. hiaticula.
	Pluvialis	P. aurea, P. squatorala, *P. morinellus*.
	Vanellus	V. cristatus.
	Hæmatopus	H. ostralegus.
	Strepsilas	S. interpres.
	Calidris	C. arenaria.
SCOLOPACIDÆ.	Scolopax	S. rusticola, S. gallinago, S. gallinula.
	Numenius	N. arquata.
	Totanus	T. hypoleucus, T. calidris.
	Tringa	T. variabilis, *T. cinerea*.
RALLIDÆ.	Rallus	*R. aquaticus*.
	Crex	C. pratensis.
	Gallinula	G. chloropus.
	Fulica	F. atra.

ORDER VII.—PALMIPEDES.

Families.	Genera.	Species.
ANATIDÆ.	Anas	A. anser.
	Boschas	B. fera, B. *crecca*.
COLYMBIDÆ.	Podiceps	*P. minor*, *P. auritus*.
LARIDÆ.	Larus	L. ridibundus, L. marinus, L. canus, L. argentatus.
	Sterna	S. hirundo.

Marine Species named are to be met with on the shore of the Frith of Forth, between Grangemouth and Queensferry. In a series of Notes, the author described, at considerable length, the structure and habits of many of the Species named in the list, and referred to specimens on the table in illustration of his remarks.

2. On an unusual Drought in the Lake District in 1859. By John Davy, M.D., F.R.SS. Lond. & Edin.

This occurrence, following an unusual fall of rain in January, took place in May, June, and July. The ordinary amount of rain in these months is,—taking the average of the last eleven years,—

at Lesketh How, Ambleside, 12·36 inches; during the months in question, at the same place, it was only 4·54 inches.

Three tables are given by the author in elucidation; the first relating to the fall of rain in five different places in the district; the second affording a summary of general meteorological observations at Kendal, more or less applicable to other parts of the district; the third containing, for the sake of comparison, the rain-fall at various places in the United Kingdom.

The author concludes with noticing the abnormal state of the weather during the whole of the year, marked by great vicissitudes of wet and drought, of heat and cold, and their effects, especially on vegetation.

3. On the Constitution of the Essential Oil of Cajeput. By Mr Maximilian Schmidl, Assistant to Dr T. Anderson, University of Glasgow.

The author shows. that oil of cajeput is a mixture of an oil boiling about 175° Cent., and one or more oils of higher boiling point. In the present paper he investigates the first of those substances. When purified by repeated distillation, it is a colourless, limpid fluid, which by analysis and determination of its vapour density, is shown to have the formula $C_{20}\ H_{16} + 2HO$. When treated with anhydrous phosphoric acid, it is decomposed, and yields a mixture of three different hydrocarbons, to which the author gives the names of Cajputene, Isocajputene, and Metacajputene. The two former, though differing in properties, have both the formula $C_{20}\ H_{16}$. The last, which is a very heavy oil, with a lemon yellow colour and brilliant fluorescence, is $C_{40}\ H_{32}$.

Monohydrate of Cajputene, $C_{20}\ H_{16} + HO$, is obtained by treating the original oil with commercial sulphuric acid at the boiling temperature, under particular precautions. The substance condenses to 4 volumes of vapour, although containing one atom of oxygen.

Hexhydrate of Cajputene, $C_{20}\ H_{16} + 6HO$ is obtained by agitating the bihydrate with dilute sulphuric acid, and leaving the mixture at rest for some time. Beautiful crystals gradually form in the mixture. The hexhydrate melts at 120° and solidifies at 85°. It is soluble in boiling alcohol and ether, from which it is deposited on cooling. Another compound, the constitution of which is not yet determined, is obtained by the action of dilute nitric acid in the cold.

Bihydrochlorate of Cajputene, $C_{20}\ H_{16} + 2HCl$ is obtained by mixing the oil with one-third of its bulk of strong aqueous hydrochloric acid, and then passing a current of the gas through the mixture; after the lapse of 10 or 12 minutes, the whole solidifies into a mass of crystals. These, when purified by expression and crystallisation from boiling alcohol, melt at 53°, and when repeatedly distilled, or when acted on by alcoholic potash, lose one-half of hydrochloric acid, and yield the monohydrochlorate. It is entirely devoid of taste and smell, and in this respect differs remarkably from the isomeric compound obtained from oil of turpentine.

Monohydrochlorate of Cajputene, $C_{20}\ H_{16} + HCl$ is an oily fluid, with a pleasant ethereal odour.

Tetrabromide of Cajputene, $C_{20}\ H_{16}\ Br_4$. Bromine is added to the bihydrate, and the mixture left for some weeks, when a granular substance is seen to deposit. As soon as this is observed, the whole is dissolved in boiling alcohol, and on cooling, glittering scales, resembling cholesterin, are deposited. It is soluble in alcohol and ether, melts at 60°, and may be distilled apparently unchanged.

Hydriodate of the hydrate of Cajputene. When iodine is added to oil of Cajeput, the temperature rises, and on cooling a black crystalline compound is deposited. 'This substance, after purification by cold alcohol, forms black crystals fusible at 80°, and very readily decomposed. Its formula is $C_{20}\ H_{16}\ HO + HI$.

Hydriodate of Cajputene, $C_{20}\ H_{16} + HI$. To obtain this compound, oil of cajeput is mixed with a solution of iodine in bisulphide of carbon, and to this a solution of phosphorus, in the same menstruum, is added. A brisk reaction takes place, the temperature rising to about 80°. After some weeks fine black crystals are deposited, which are soluble in alcohol and ether, and exceedingly stable, being unaffected even by alkaline solutions.

The author proposes to make the composition of the other constituents of the oil of cajeput the subject of a future paper.

4. On the Action of Chlorine on Citric Acid. Hexachlorinated Acetone. By John Galletly, Esq.

At the recommendation of Dr Anderson, Glasgow University, I have re-examined the oil which Plantamour obtained by acting on citric acid with chlorine. Owing to the slowness with which it is formed, its complete investigation is somewhat lengthened, and the following results are all I have as yet obtained. A considerable part of the work has been done in the Glasgow College Laboratory.

Plantamour found that when a strong solution of citric acid was exposed to the action of chlorine in the sunshine, a heavy oil appeared on the surface of the liquid, gathering in drops and sinking to the bottom. He describes the properties of this oil,* and ascribes to it the formula $C_8\ Cl_8\ O_3$. In his examination of acetone,† Staedeler found that a substitution product of this body, with five atoms of chlorine replacing hydrogen, resembled Plantamour's oil in every respect, and that the percentage composition of hexachlorinated acetone corresponded exactly with Plantamour's formula. There could therefore be very little doubt left as to its composition; but as I had the following analyses made before I was aware of Staedeler's suggestion, and as Plantamour procured a potash salt from it to which he assigns a formula having eight atoms carbon, and as his own analyses were not given in the memoir, I have published the following to remove any doubt.

Upwards of twenty half-gallon bottles filled with chlorine, having a little of a saturated solution of citric acid in each, required many weeks exposure to sunshine to yield about a fluid ounce of the oil. There seemed to be no other substance formed, unless, perhaps, hydrochloric acid and water. After drying over chloride of calcium it distilled entirely about 400° Fahr. I found its density at 60° Fahr. to be 1·748. Its properties agree very exactly with Plantamour's description.

I. { 7·200 grs. substance gave
3·620 grs. carbonic acid,
·200 grs. water.

II. { 9·250 grs. substance gave
29·790 grs. chloride of silver.

	Experiments.		Theory.		
	I.	II.			
Carbon,	13·71	—	13·58	C_6	36
Chlorine,	—	79·67	80·38	Cl_6	213
Oxygen,	—	—	6·04	O_2	16
			100·00		265

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* See Rapport Annuel de Berzelius 7e année.

† Nachricht, von der Gesellsch. der Wiss. Zu Göttingen. 1853. No. 9.

The following data were obtained in determining the vapour density :—

Temperature of air 20° Cent.,
,, of vapour at sealing 247° Cent.,
Excess of weight of balloon ·810 gramme,
Capacity of balloon, 165 cub. centimètres,
Residual air, . 7 ,, ,,
Barometer, 30·20 inches,
Density, 9·417 inches.

The formula $C_6 \, Cl_6 \, O_2$ requires 265 × ·0346 = 9·169.

This oil is not decomposed by sodium, or at least very slowly, even with heat. It is not affected by boiling with oxide of silver, oxide of mercury, or even baryta water.

When the substance is agitated with water and cooled to 6° Cent. a crystalline hydrate is formed, which, according to Plantamour, fuses at 15° Cent. = 59° Fahr. This hydrate is $C_6 \, Cl_6 \, O_2 + 2HO$ (Staedeler). It often appears as a net-work of long crystals on the sides of the bottles in which the oil is formed, but these crystals may sometimes be heated considerably above the fusing point given by Plantamour without melting. I found, on keeping the oil under water for some months, that it turned into an opaque white mass of crystalline plates, which did not fuse till heated to a temperature of about 40° Fahr. When these crystals were melted again under water, they solidified shortly after cooling, without the fusing point being lowered. As this does not happen when the oil is freshly made, it is probable that the hexachlorinated acetone passes into some isomeric modification like the analogous body chloral. This hydrate disolves very readily in ether in the cold, giving long crystals covering the sides of the basin as the ether evaporates. If heat be employed to dissolve the crystals, the hydrate is decomposed and the oil separates.

When gaseous ammonia is passed into hexachlorinated acetone, it becomes solid, and there is an evolution of chloroform. The solid substance was washed with water, and crystalised from alcohol, when it formed large pearly square tables. A few grains of this body left some hours in the water-bath entirely volatilises. Its character and composition agree exactly with trichloracetamide, the following numbers having been obtained on analysis :—

	Theory.	Experiment.
Carbon	14·77	14·97
Hydrogen	1·23	1·52
Chlorine	65·54	65·14
Nitrogen	8·61	8·59
Oxygen	9·85	—
	100·00	

The same body is got by using aqueous ammonia; the decomposition taking place according to the following equation :—

$$\underset{\text{Hexachlor.}}{C_6\,Cl_6\,O_2} + \underset{\text{Acetone.}}{NH_3} = \underset{\text{Chloracetamide.}}{C_4\,Cl_3\,O_2\,NH_2} + \underset{\text{Chloroform.}}{C_2\,H\,Cl_3}$$

The products of decomposition with ammonia are therefore the same as those obtained when this alkali acts on the chlorinated ethers and aldehydes. I got a similar result with potash, which differs from the experience of Plantamour, who found the salt of a new acid which he names Bichloroxalic Acid. On dissolving the oil in alcoholic potass, it became warm and deposited chloride of potassium; and the alcoholic mother liquor, when left to spontaneous evaporation, gave long silky needles containing 53·08 per cent. chlorine. This agrees exactly with trichloracetate of potass, which contains 52·85 per cent. chlorine. The decomposition being evidently

$$\underset{\text{Hexachlor.}}{C_6\,Cl_6\,O_2} + \underset{\text{Acetone.}}{KO\,HO} = \underset{\text{Trichloracetate Potas.}}{C_4\,Cl_3\,KO_4} + \underset{\text{Chloroform.}}{C_2\,H\,Cl_3}$$

The paper in which these crystals were pressed when heated with water gave a solution which abundantly reduced nitrate of silver, showing the presence of formic acid from the further decomposition of the chloroform by the alcoholic potass.

It seemed to me probable that, by treating ethylate of soda with the oil, a decomposition would ensue in which a homologue of chloroform would be obtained, the ethyl replacing the hydrogen in this body. The decomposition, however, turned out differently. A considerable quantity of trichloracetic ether was produced, easily recognised by its fragrant peculiar odour, and among other bodies, chloroform and common salt.

The remainder of my material was expended in one or two preliminary experiments on its action on the volatile organic bases. It appears that like ammonia they give ordinary chloroform, when one of the radicals is hydrogen, the compound radical entering the chloracetamide. Thus the decomposition with aniline is as follows :—

$$\underset{\text{Aniline.}}{(C_{12}H_5)\,H_2N} + \underset{\text{Hexachlor Ac.}}{C_6Cl_6O_2} = \underset{\text{Trichloracetanilide.}}{C_4Cl_3O_2NH\,(C_{12}H_5)} + \underset{\text{Chloroform.}}{C_2\,H\,Cl_3}$$

The change occurs in the cold. Trichloracetanilide crystalises in colourless prisms of some size. It is insoluble, or very sparingly soluble, in cold water, but dissolves in warm water pretty readily, filling the liquid with silky needles as the solution cools. I expected that, like chloracetamide, it would sublime without decomposition, which it partly did; but there is a great loss, and much charcoal is left. I had barely enough left to ascertain by experiment its exact composition, and the analysis of the sublimed substance gave an excess both in carbon and hydrogen, but the method of formation and its properties leave no doubt about the formula. As I intend to continue the subject, I shall probably have an opportunity of publishing an exact analysis. When rapidly distilled with strong solution of potass, or with soda lime, there is formed besides aniline a new volatile base, with a very peculiar pungent odour. This body seems rather easily decomposed, but I had far too little to be able to give a particular account of it at present.

When the oil is mixed with a base containing a triatomic radical, such as lutidine, no chloroform is evolved. The liquids mix, but there is no apparent action in the cold, and when heat is applied, the decomposition is so violent that only a charcoal-like residue is left.

The summer being the only season when the oil can be conveniently prepared by Plantmour's process, I have made some experiments with a view to find other methods of procuring it, which I may mention here. Staedeler found that chlorinated acetones were procured by distilling citric acid with chlorate of potass and hydrochloric acid. The oil which I procured in this way had a specific gravity of 1·726, and boiled between 360° and 400° F. It was evidently a mixture of his pentachlorinated and hexachlorinated acetone. It is extremely irritating, causing great pain in the eyes, and can scarcely be distilled except with special arrangement for carrying off the vapours. I procured by a few distillations a portion of fluid having very nearly the specific gravity and boiling point of Plantamour's oil, but the irritating action of its vapour was scarcely diminished. It gave likewise the solid compound when mixed with aniline, so that there is no doubt about the identity of the bodies. I distilled in the sunshine the mixture given above, in the hope that the product might be only hexachlorinated acetone, but a violent explosion put an end to the experiment. The mixture obtained in this way is evidently the same as that Plantamour got by acting with chlorine on a citrate.

The similar oil got from citric acid, oxide of manganese, and hydrochloric acid, had only a specific gravity of 1·50 and a portion boils even below 212°, but the greater part seems to be pentachlorinated acetone. From the low boiling point of some of the fractions, it may be questioned whether these bodies are all chlorinated acetones.

The action of chlorochronic acid is too violent, and I have not been able to find a better mode of preparing the oil than the slow action of chlorine in the sunshine, which gives it pure without any trouble.

The pentachlorinated acetone decomposes with aniline in a similar manner with the body described, giving what is probably bichloracetanilide.

5. Notice of a Panoramic Sketch of Kashmir, recently received from India. By Professor C. Piazzi Smyth.

A recent panoramic topographical view of the interesting region of Kashmir having been just communicated to me by my friend, Mr Roger Montgomerie, Advocate, I have found it so remarkably well executed, in its almost photographic representation of natural features of hill and plain, that I have obtained his leave to present it to the Royal Society, accompanying the presentation with the following few particulars, abstracted from MS. reports.

The view in question is by Captain Montgomerie, B.E., who, under the general direction of Col. A. Scott Waugh, the Director of the Indian Trigonometrical Survey, has been constantly at work in Kashmir and Thibet since 1855, and with such energy and success, that he has completed the accurate triangulation, as well as the topographical surveying, of 40,000 square miles of country in four years. The whole of that extent, too, lay in a very difficult region, abounding in snowy peaks; one of which, a newly discovered point on the Kara-Koran, is probably the second highest mountain in the world; the measured height, subject only to a small probable correction, to be determined by an extensive levelling operation now in progress, being 28,278 feet.

The most important part, however, socially of the whole region visited, was the world-famous valley of Kashmir, where the splendid climate, traces of an ancient civilization, and considerable present wealth, skill, and industry, combined to add their influence to the beauties of mountain scenery.

Of the leading features in the physical geography of Kashmir Captain Montgomerie's panorama seems to give a very accurate idea; for, before the skill of the artist was called in to represent light and shade, the vertical and horizontal angles between all important points were laid down with a theodolite. In length, he describes the valley to measure one hundred and ten miles, in a S.E. and N.W. direction, with a breadth of about seventeen miles, and a mean elevation above the sea of 5200 feet. A considerable portion, or about ninety miles in length, is so nearly flat, that the river Vedusta (Jhelum), which flows through it, is navigable for that extent in large boats. The flat ground is, however, in two terraces, the upper one consisting of remains of an ancient clayey stratum, some two to three hundred feet thick. It is found often in isolated patches, several miles long and broad, with steep cliff-like edges.

The higher level thus formed was once artificially irrigated, but is now sadly neglected, while the greater part of the lower level is subject to inundation, and is more or less in a marshy condition, or absolute lake, as in the immediate neighbourhood of the capital city. The country, however, including the surrounding mountains, still contains no less than 4606 villages, spread over an extent of 8100 square miles.

On the slopes of the hills cultivated tracts are again met with alternating with grazing grounds, and forests of cedars, pines, and firs. At 7000 and 9000 feet these predominate; while above that level, and extending to 12,000 feet, there are grassy regions visited by the ponies, cows, and sheep, during half June, all July, August, and half September; these being, in fact, the only months when localities so elevated are free from snow. On the higher peaks, rising to 15,000 and 18,000 feet, snow is perpetual; and there are large glaciers between their spurs.

Even when among the smaller hills, the surveyor's labours were by no means light; and according to the extensive experience of Colonel Waugh, the Director of the Indian operations, it is not often that sufficient mathematical and artistic skill are found in any one individual, conjoined to the necessary bodily vigour; *i. e.*, to be able to clamber out of hot Himalayan valleys up the steep slopes leading to exposed and windy eminences, and there stand uninjured, while making all the necessary observations, with the full amount of attention to accuracy and fulness of detail that is proper; and even when these desirable qualities are found, they do not last, he says, in the generality of individuals more than a few seasons.

The inconveniences, however, of the lower country, and the "filling in" survey, were greatly surpassed by what was experienced during the scientific part of the triangulation, which was necessarily for the most part carried on amongst the peaks of the snowy range; out of sixteen principal stations in Thibet, fourteen being above 15,000 feet high, and two of them, Shinishah and Shunika, being respectively 18,417 and 18,224 feet. Nevertheless, no pains were spared in procuring good work, as the following extracts may best show in Captain Montgomerie's own words:—

"12. The triangulation depends on the Kashmir series which emanates from a side of the N.W. longitudinal series in the low hills near Sealkote.

13. "In order to connect the triangulation in the Punjab with Kashmir, it was necessary to carry the triangles across the Chatadhar and Pir Paujal snowy ridges. This was done by taking observations from the tops of the snowy peaks best adapted to form a series of symmetrical polygons and quadrilaterals. In this way the triangulation has been carried on systematically from the foundation. It consists of one main axis, viz., the principal triangulation, which is composed of polygons and quadrilaterals. From this axis diverge numerous minor series of triangles, which, starting from one side of the principal series, are tested by closing on another side of the same, or upon a side of the N.W. Himalayan series.

"14. From these minor series, secondary stations have been fixed, so as to cover the whole country with tested trigonometrical points.

"15. Though the country to be surveyed was so elevated, the rigorous rules of the Great Trigonometrical Survey of India were adhered to throughout.

"16. The highest points suited to the triangulation were always occupied, and observations were taken from stations upwards of 16,000 feet above the level of the sea.

"17. On the principal series of triangles, the observations were invariably made to luminous signals, viz., heliotropes and lamps, notwithstanding the physical difficulties and the severity of the climate on the snowy peaks, so especially trying to the natives of India who served the signals.

"18. Numerous observations being required, it was necessary for me to reside on the peaks for at least two days and nights, generally more.

"19. Some of the peaks below 14,000 feet lose the greater part of their snow by September; but practically, it was necessary to observe from most of the stations earlier in the season, when the snow was still heavy at 11,000 feet.

"20. Occasionally, in consequence of clouds and storms, the party had to remain pitched on the snow for upwards of a week at a time.

"21. On the Pir Paujal peaks, the electricity was so troublesome, even when there was no storm, that it was found necessary to carry a portable lightning conductor for the protection of the theodolite.

"22. Space sufficient, even for our very small camp, could never be got quite close to the stations on the peaks; during the day this did not matter, but at night, though the distance might not be more than 200 yards, it was rather a difficult matter to get back from the Observatory tent to the camps, after I had finished taking the observations. Soon after sunset the surface of the snow becomes as slippery as glass, affording by no means a satisfactory footing on a narrow ridge, with a precipitous slope, or a precipice, on either side."

In addition to these physical difficulties, it should be mentioned that there were others of a political kind; for Kashmir and Thibet are independent countries, and the inhabitants saw their hills ascended and encamped on by British surveyors with great distrust. Nevertheless, Captain Montgomerie displayed so much tact that he completely won the confidence and regard at last both of the Maha Rajah Golab Sing and the Maha Rajah Rumheer Sing. Then the too memorable mutiny of 1857 broke out; and while most of the captain's European assistants were withdrawn to assist in the military operations, the natives who were left with him had come from the same plains of Hindostan as the rebellious Sipahis, nevertheless all the attendants proved faithful; and except on one occasion the progress of the survey was not interfered with.

It will thus be seen, that the great Indian trigonometrical survey which began amongst the pestilential jungles of southern India, and worked gradually, northward under Lambton and Everest, has now at last reached the greatest mountain chain in the world; and never before were such great heights submitted to the processes of accurate geodesy. The occasion appears to have called forth a deal of peculiar talent among our Indian officers; and amongst those who have specially shone forth in this calling was an assistant of Captain Montgomerie's, who subsequently joined the army before Delhi and Lucknow, and was killed before the latter place by an accidental explosion of powder. He was lamented much by the surveyors, among whom he was unrivalled in physical power, endurance, and cheerfulness under fatigue; his adventures and achievements amongst the snowy mountains had been the frequent theme of praise and admiration in many an encampment; and he had intended to devote his rare and splendid qualities as a mountain surveyor, had he survived, to the exploration of central Asia on rigorous principles.

Captain Montgomerie is now actively at work, continuing in the higher regions of Thibet what he began and carried out so well in the lower valley of Kashmir.

The following Gentleman was balloted for, and duly admitted an Ordinary Fellow:—

WILLIAM CHAMBERS, Esq. of Glenormiston.

The following Donations to the Library were announced:—

Second Annual Report of the General Board of Commissioners in Lunacy for Scotland. Edin. 1860. 8vo.—*From the Commissioners.*

Journal of the Royal Asiatic Society of Great Britain and Ireland. Vol. XVII. Part II. 8vo.—*From the Society.*

Canadian Journal. March, 1860. 8vo.—*From the Canadian Institute.*

Quarterly Journal of Chemical Society. No. 48.—*From the Society.*

Appendix to Messrs Stevenson's Answer to Sir David Brewster's Reply regarding Dioptric Lights. By D. and T. Stevenson. —*From the Authors.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Nos. 14 and 15.—*From the Academy.*

Von der Bedeutung der Sanskritstudien für die griechische Philologie. Von Dr W. Christ. 4to.—*From the Royal Bavarian Academy.*

Rede in der öffentlichen Sitzung der k. Akademie der Wissenschaften. Am 28. Marz 1860. Gehalten Von Justus F. Von Liebig. 4to.—*From the same.*

Proceedings of the Royal Medical and Chirurgical Society of London. Vol. III. No. 3. 1860. 8vo.—*From the Society.*

Proceedings of the Zoological Society of London. Part 3. 1859. 8vo.—*From the Society.*

Monthly Return of Births, Deaths, and Marriages. March, 1860. —*From the Registrar-General.*

Monday, 30th April 1860.

Professor CHRISTISON, Vice-President, in the Chair.

The following Communications were read:—

1. Account of the Asafœtida Plants (*Narthex Asafœtida* (Falconer), which have recently flowered and fruited in the Edinburgh Botanic Garden. By Professor Balfour.

The author gave an account of the cultivation of plants of Asafœtida in the Edinburgh Botanic Garden since the year 1842, and of the flowering and fruiting of specimens in 1858 and 1859. He then described the characters of the plant (*Narthex Asafœtida* of

Falconer), and illustrated his communication by specimens of the plant, by photographs, and by drawings from the accurate pencil of Dr Greville.

2. On the Composition of the Glassy Surface of some Vitrified Forts. By Thomas Bloxam, F.C.S., Assistant Chemist to the Industrial Museum of Scotland.

The present paper was undertaken at the suggestion of the late Professor George Wilson, as forming an interesting inquiry, both to the antiquarian and the chemist, and as a sequel to the paper upon old Scotch glass, communicated by me to this Society some time since.

The investigation had for its object,—

1*st*, To ascertain the exact composition of the glassy surfaces of the various specimens.

2*d*, The composition of the rocks upon which the glass was formed.

3*d*, To account for the formation of such glass by the information afforded by the first two inquiries.

Vitrified forts, or sites, as some prefer to call them, are spaces of ground enclosed by a wall composed of pieces of rocks placed upon each other without mortar, and the surfaces of which are covered with a glassy matter. It is scarcely the province of the chemist to speculate as to the purpose for which these sites were erected, or the manner in which the vitrification was brought about: we will therefore proceed with the inquiries set forth at the commencement.

Of the many vitrified forts existing in Scotland, two of the best were selected for investigation—the one, "Duno'deer," from Aberdeenshire, kindly forwarded by Mr Stuart of the Society of Antiquaries; the other, "Knockfarrel," from Strathpeffer, Ross-shire, procured for me by my friend Dr M. Thomson.

Both these specimens exhibited vitrification in a marked degree. The specimen from Duno'deer presented two surfaces of a vitrified nature, the one being more porous in appearance than the other; separate portions of these surfaces were carefully broken off for analysis, and distinguished as upper and under surface, the under one being the more porous. The specimen was coated with moss in parts, but these were excluded from the quantity selected for analysis. The vitrified surfaces were spread over rocks of different nature, such as coarse sandstone, and pinkish white portions of a body resembling felspar.

By a preliminary test, the powdered glassy matter was found to contain metallic iron, and where the vitrified material existed in sufficient quantity, the following points were ascertained:—

1. The specific gravity.
2. Action of alkalies and acids.
3. Chemical composition.

The specific gravity ascertained in the manner usually adopted in the laboratory was found to be 2·35.

The method used for the analysis was the same that is generally employed for silicates, the iron, as peroxide, separated from the alumina by reduction in hydrogen, and subsequent separation by permanganate of potash; the metallic iron was estimated by measuring the quantity of hydrogen evolved from a known weight of substance.

The alkalies present were estimated by fusion of the substance with baryta.

The upper surface of Duno'deer was soluble in acids to the amount of 20·46 per cent., consisting of silica, peroxide iron, protoxide of iron, alumina, and lime.

Alkalies acted upon it to a small extent, dissolving only 0·93 of a grain per cent., which was composed mainly of silica and alumina.

The quantitative composition was found to be the following:—

Silica, . .	46·80	
Peroxide iron, .	19·92	Ratio of oxygen in the bases to that of silica as 1 : 1.
Alumina, . .	20·07	
Lime, . .	7·81	
Magnesia, . .	0·89	
Iron, . .	0·11	Oxygen quotient, 0·76.
Potash, . .	0·94	
Soda, . .	3·44	
	99·98	

The under surface of this specimen was not so uniform in appearance as the upper one, small crystals resembling felspar being scattered through it; these crystals, however, were not included in the portion taken for analysis. As the vitrified surface was smaller in extent than that of the preceding specimen, the action of acids and alkalies had to be omitted.

The specific gravity was 2·54, and the quantitative composition—

Silica,	44·21	
Peroxide iron,	19·24	Oxygen ratio as 1 : 1.
Alumina,	23·26	
Lime,	7·64	
Magnesia,	2·34	Oxygen quotient, 0·87.
Soda,	2·57	
Potash,	0·95	
Iron,	0·31	
	100·52	

The body resembling felspar was next examined; the crystals did not effervesce with acids, were easily powdered, and, when heated at the blow-pipe flame, they fused at the edges, and were easily marked with a knife.

The specific gravity was 2·37, and the chemical composition:—

Silica,	78·45	Oxygen ratio as 1 : 5.
Alumina,	13·39	
Lime,	1·48	
Peroxideiron,	1·31	Oxygen quotient, 0·209.
Potash,	1·24	
Soda,	4·90	
	100·77	

From the above analysis, the substance most resembles albite or soda-felspar; the excess of silica, and consequent reduction of the oxygen quotient, may be accounted for by the fact of its having undergone considerable weathering, and also that small quanities of quartz might have been associated with the specimen used for analysis.

The sandstone forming part of the fort was of a coarse variety, and evidently, from its appearance, had been exposed to considerable heat; it contained less silica than is usually found in building sandstones.

Analysis afforded the following results:—

Silica,	68·80
Peroxide iron,	5·00
Alumina,	19·15
Lime,	2·25
Magnesia,	0·60
Potash,	2·54
Soda,	1·66
	100·00

The last specimen of vitrified fort examined was from Knockfarrel; the vitrified portion was very distinct, but owing to the small quantity at my disposal, the preliminary experiments had to be omitted. The rocks collected in the immediate vicinity were for the most part red granite and gneiss.

The specific gravity was 2·85, and the chemical composition—

Silica, . .	54·42	
Peroxide iron, .	15·19	Oxygen ratio as 1 : 2.
Alumina, . .	19·72	
Magnesia, . .	2·49	
Lime, . .	6·42	Oxygen quotient, 0·57.
Soda, . .	0·07	
Potash, . .	0·61	
	98·92	

It will be seen by comparing the whole analyses, that the two surfaces of the vitrified fort Duno'deer, differ from each other in very slight degree, and, from the presence of alumina and soda, it appears most probable that the felspar with which it is associated has played an important part in the formation of the glass, its fusion being aided by the alkali furnished in the ashes of the wood used, the lime might also be derived from the same source.

The vitrified fort, Knockfarrel, resembles that of Duno'deer, although not closely, and from the fact of micaceous rocks being found in the vicinity, it is most likely that these rocks entered into the composition of the vitrified material.

Of the small quantity of metallic iron found in Duno'deer it perhaps is scarcely necessary to say much; but it is quite possible that it may either have existed as such in the basaltic rocks, or have been reduced from the state of oxide, a constituent of augite and olivine.

The following general conclusions may be drawn from the information afforded by the analyses:—

1*st*, That these vitrified surfaces must have been produced by the bringing together of certain rocks, and exposing them to a high temperature.

2*d*, That these rocks were not collected without regard to their relative powers of melting.

3*d*, That such a collection of rocks, basaltic, gneiss, and felspathic, would at high temperature produce a glass with wood ashes, similar in composition to these vitrifications.

I subjoin a tabulated view of the analytical results:—

	Duno'deer, upper surface.	Duno'deer, under surface.	Felspathic substance	Knockfarrel.
Silica..............	46·80	44·21	78.45	54·42
Peroxide iron.....	19·92	19·24	1·31	15·19
Alumina..........	20·07	23·26	13·39	19·72
Lime	7·81	7·64	1·48	6·42
Iron..............	0·81	0·31	...	...
Potash............	0·94	0·95	1·24	0·61
Soda...............	3·44	2.57	4·90	0·07
Magnesia.........	0·89	2·34	...	2·49
	99·98	100·52	100·77	98·92
Specific gravity..	2·35	2·54	2·37	2·85
Oxygen ratio.....	1 : 1	1 : 1	1 : 5	1 : 2
Oxygen quotient.	0·76	0·87	0·20	0·57

3. On the Reduction of Observations of Underground Temperature, with applications to Professor Forbes' Edinburgh Observations and the continued Calton Hill Series. By Professor William Thomson, Glasgow.

The principle followed in the reductions which form the subject of this communication may be briefly stated thus:—

The varying temperature during a year, shown by any one of the underground thermometers on an average for a series of years, is expressed by the ordinary method in a trigonometrical series of terms representing simple harmonic variations*,—the first having a year for its period, the second a half year, the third a third part of a year, and so on. The yearly term of the series is dealt with separately for the thermometers at the different depths, the half yearly term also separately, and so on, each term being treated as if the simple periodic variation which it represents were the sole variation experienced. The elements into which the whole variation is thus analysed are examined so as to test their agreement with the elementary formulæ by which Fourier expressed the periodic variations of temperature in a bar protected from lateral conduction, and experiencing a simple harmonic variation of temperature at one end,

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[*] By a simple harmonic variation is meant a variation in proportion to the height of a point which moves uniformly in a vertical circle.

or in an infinite solid experiencing at every point of an infinite plane through it a variation of temperature according to the same elementary law. In any locality in which the surface of the earth is sensibly plane and uniform all round to distances amounting at least to considerable multiples of the depth of the lowest thermometer, and in which the conducting power of the soil or rock below the surface is perfectly uniform to like distances round and below the thermometers, this theory must necessarily be found in excessively close agreement with the observed results. The comparison which is made in the investigations now brought forward must be regarded, therefore, not as a test of the correctness of a theory which has mathematical certainty, but as a means of finding how much the law of propagation of heat into the soil is affected by the very notable deviations from the assumed conditions of uniformity as to surface, or by possible inequalities of underground conductivity existing in the localities of observation. When those conditions of uniformity are perfectly fulfilled both by the surface and by the substance below it, the law of variation in the interior produced by a simple harmonic variation of temperature at the surface, as investigated by Fourier, may be stated in general terms in the three following propositions:—(1.) The temperature at every interior point varies according to the simple harmonic law, in a period retarded by an equal interval of time, and with an amplitude diminished in one and the same proportion, for all equal additions of depth. (2.) The absolute measure in ratio of arc to radius, for the retardation of phase, is equal to the diminution of the Napierian logarithm of the amplitude; and each of these, reckoned per unit of length as to augmentation of distance from the surface, is equal to the square root of the quotient obtained by dividing the product of the ratio of the circumference of a circle to its diameter into the thermal capacity of a unit of bulk of the solid, by the thermal conductivity of the same estimated for the period of the variation as unity of time. (3) For different periods, the retardations of phase, measured each in terms of a whole period, and the diminutions of the logarithm of the amplitude, all reckoned per unit of depth, are inversely proportional to the square roots of the periods.

The first series of observations examined by the method thus described were those instituted by Professor Forbes, and conducted under his superintendence during five years, in three localities of

Edinburgh and the immediate neighbourhood; (1.) The trap rock of Calton Hill; (2.) The sand below the soil of the Experimental Gardens; and (3.) The sandstone of Craigleith Quarry. In each place there were, besides a surface thermometer, four thermometers at the depths of 3, 6, 12, and 24 French feet respectively. The diminution in the amplitude, and the retardation of phase in going downwards, has been determined for the annual, for the half-yearly, third-yearly, and the quarterly term, on the average for these five years for each locality. The same has been determined for the average of twelve years of observation, continued on Calton Hill by the staff of the Royal Edinburgh Observatory.

The following results with reference to the annual harmonic term are selected for example :—

Average of five years, 1837 *to* 1842.

	Retardation of phase in days, per French foot of descent.	Retardation of phase in circular measure, per French foot of descent,	Diminution of Napierian logarithm of amplitude, per French foot of descent.
Calton Hill.			
3 feet to 6 feet.	......	·11635	·12625
6 „ 12 „	......	·11344	·12156
12 „ 24 „	......	·11490	·10959
Mean, or 3 to 24.	6·68 days.	·1147	.1154
Experiml. Garden.			
3 feet to 6 feet.	......	·11635	·10037
6 „ 12 „	......	·11929	·11304
12 „ 24 „	......	·10617	·10844
Mean, or 3 to 24.	6·6 days.	·11137	·10859
Craigleith Quarry.			
3 feet to 6 feet.	......	·063995	·09372
6 „ 12 „	......	·066903	·06304
12 „ 24 „	......	·066903	·06476
Mean, or 3 to 24.	3·86 days.	·066489	·06840

If Fourier's conditions of uniformity, stated above, were fulfilled strictly, the numbers shown in the second column for each locality would be equal to one another, and equal to those in the third column. The differences between the actual numbers are surprisingly small, but are so consistent that they cannot be attributed to errors of observation. It is possible they may be due to a want of perfect agreement in the values of a degree on the different thermometric scales; but it seems more probable that they represent true discrepancies from theory, and are therefore excessively interesting, and possibly of high importance with a view to estimating the effects of inequalities of surface and of interior conductivity. The final means of the numbers in the second and third columns are

Calton Hill . . .	·11702
Experimental Garden .	·11061
Craigleith Quarry . .	·06988

The thermal capacities of specimens of the trap rock, the sand, and the sandstone of the three localities were, at the request of Professor Forbes, measured by Regnault and found to be respectively

·5283, ·3006, and ·4623.

Hence, according to proposition (3), stated above, the thermal conductivities are as follows:—

Trap rock of Calton Hill, . . .	121·2
Sand of Experimental Garden, . .	77·19
Sandstone of Craigleith Quarry, . .	273·6

These numbers do not differ much from those given by Professor Forbes, who for the first time derived determinations of thermal conductivity in absolute measure from observations of terrestrial temperature. In consequence of the peculiar mode of reduction followed in the present investigation, it may be assumed that the estimates of conductivity now given are closer approximations to the truth. To reduce to the English foot as unit of length, we must multiply by the square of 1·06575; to reduce, further, to the quantity of heat required to raise 1 lb of water by 1° as unit of heat, we must multiply by 66·447; and lastly, to reduce to a day as unit of time, we must divide by 365¼. We thus find the following results:—

Trap rock of Calton Hill, . . .	23·5
Sand of Experimental Garden, . .	15·0
Sandstone of Craigleith Quarry, . .	53·5

These numbers show the quantities of heat per square foot conducted in a day through a layer of the material one foot thick, kept with its two surfaces at a difference of temperature of one degree,—the unit of heat being, for instance, the quantity required to raise 1000 lbs of water by $\frac{1}{1000}$th of a degree in temperature.

The same system of reduction applied to the observations continued at the Calton Hill station, has led to results from which the following are selected :—

Average annual term for 12 *years*—1842 *to* 1854—*Trap rock to Calton Hill.*

	Col. 1.	Col. 2.	Col. 3.	Col. 4.	Col. 5.
Depths below surface in French feet.	Proportionate Diminution of amplitude.	Diminution of Napierian logarithm of amplitude per French foot of descent.	Retardation of epoch in circular measure, per Fr. foot of descent.	Retardation of epoch in decimal of a year, per Fr. foot of descent.	Retardation of epoch in days, per Fr. foot of descent.
3 feet to 6 feet	·675	·1310	·1233	......	......
6 „ 12 „	·498	·1163	·1142	......	......
12 „ 24 „	·260	·1121	·1145	......	......
3 „ 24 „	·0875	·1160	·1157	·01841	6·724

By these results it will be seen that the discrepancies from the theory based on the hypothetical conditions of uniformity, noticed above as found in the reduction of the first five years' series of observations, are maintained with the same character, and to nearly the same amount, in the succeeding series of thirteen years. An investigation of the changes of conductivity and specific heat, which, if the ground were level and the surface uniform, would be required to account for these discrepancies, is made, so far as the data suffice for determining them. The paper concludes with the solution of some practical problems regarding the conduction of heat through rock possessing the conductivity determined by the reductions which form the chief part of the paper.

4. On a Method of Reducing Observations of Underground Temperatures, with its Application to the Monthly Means recorded in the Report of the Royal Observatory of Edinburgh, &c. By Professor Everett.

In this paper the same general method of reduction as that of Professor Thomson, explained in the preceding paper, is followed. The numerical labour is, however, much diminished by using the monthly means given in the observatory report as data for twelve equations of condition, instead of the methods by which Professor Forbes had obtained data for twelve, and Professor Thomson for thirty-two equations of condition. The method adopted in the present communication, although not susceptible of such minute accuracy as the more elaborate methods referred to, seems to be as accurate as is necessary for a fair representation of the phenomena, and has a great advantage in point of simplicity and ease of working. In the present communication the practical methods of calculating the amplitudes and arguments of the successive terms in the harmonic expression of a periodic variation are fully explained, as it is believed the method will be found useful in the reduction of almost every class of meteorological observations, and as in this country, at all events, there is not much familiarity with it among practical meteorologists.

The following Donations to the Library were announced:—

Herring Fisheries of Scotland. 1860.—*From the Board of Fisheries.*

Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences. No. 16.

Report and Diagram showing the Rise and Fall of the Irawadi River for the Three Years 1856–58.—*From the Secretary of State for India.*

Total Solar Eclipse, 1860, July 18. Revised Path of the Shadow. 8vo.—*From J. R. Hind, Esq.*

The Atlantis. No. V. January, 1860. 8vo.—*From the Catholic University of Ireland.*

Drawings of the Two Araucarites of Granton Quarry.—*From Robert Allan, Esq.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. IV. 1860–61. No. 53.

Seventy-Eighth Session.

Monday, 26th November 1860.

Dr CHRISTISON, V. P., in the Chair.

The following Council were elected:—

President.

His Grace The DUKE OF ARGYLL, K.T.

Vice-Presidents.

Sir David Brewster, K.H.
Dr Christison.
Professor Kelland.
Hon. Lord Neaves.
The Very Rev. Dean Ramsay.
Principal Forbes.

General Secretary,—Dr John Hutton Balfour.

Secretaries to the Ordinary Meetings,—Dr Playfair, Dr Allman.

Treasurer,—J. T. Gibson-Craig, Esq.

Curator of Library and Museum,—Dr Douglas Maclagan.

Councillors.

Andrew Murray, Esq.
Rev. Dr Lee.
D. Milne Home, Esq.
Professor C. Innes.
Dr Lowe.
Professor W. J. M. Rankine.
James Dalmahoy, Esq.
Dr John Brown.
Professor Fraser.
James Leslie, Esq. C.E.
Dr Schmitz.
Dr Seller.

Monday, 3d December 1860.

His Grace the Duke of Argyll, President, delivered the following Opening Address:—

One of the duties which devolve upon me to-night, and one with which it is perhaps best that I should begin, is the melancholy duty of recording the names of those whom death has separated from our fellowship during the Session 1859–60. They are as follows:—

William Alexander, Esq.
Dr James Andrew.
Rt. Hon. Lord Arbuthnot.
Sir T. M. Brisbane, Bart.
Dr George Buist.
Hon. Mountstuart Elphinstone.
Sir James Forrest, Bart.
Sir John Hall, Bart.
John Lizars, Esq.
Sir John Melville.
Dr George Wilson.

The Fellows elected in Session 1859–60 are eight,—

Dr William Robertson.
Dr Frederick Guthrie.
J. Alfred Wanklyn, Esq.
Professor MacDougall.
George A. Jamieson, Esq.
Rev. Leonard S. Orde.
Patrick Dudgeon, Esq.
William Chambers, Esq.

Total Number of Fellows for 1859, . .	256
" " 1860, . .	253

I grieve to add, that the last twenty-four hours has added to the list of deaths the distinguished name of the Rev. Dr James Robertson, Professor of Church History in the University of Edinburgh.

As I rejoice to hear that a detailed memoir of our late President is to be communicated to the Society at a later period, I shall not feel it incumbent on me to do more than trace the main outlines of his public career.

Sir T. Brisbane was descended from an ancient and honourable family, whose representative occupied the high place of Chancellor of Scotland in the middle of the fourteenth century. He was born in 1773, and entered the army in 1789. A contemporary of Arthur Wellesley, he was early thrown into his society in Ireland;

and thus began a friendship which was cemented by a close companionship in arms, and lasted to the end of the great captain's life. Sir Thomas Brisbane's active military service began in 1793, in which year his regiment formed part of the Duke of York's expedition to Holland. From 1795 to 1798 he was engaged in the various affairs by which the West India Islands were successively reduced. It was during his voyage out in 1795, that having been in imminent danger of shipwreck in a collier transport, from the ignorance of the captain, he was first led to direct his attention to astronomical observation. "Reflecting," he says, "that I might often, even in the course of my life and services, be exposed to similar errors, I was determined to make myself acquainted with navigation and nautical astronomy; and for that purpose I got the best books and instruments, and in time became so well acquainted with those sciences, that, when I was returning home, I was enabled to work the ship's way: and having since crossed the tropics eleven times, and circumnavigated the globe, I have found the greatest possible advantage from my knowledge of lunar observation and calculations of the longitude."

Having acquired by purchase in 1799 the lieutenant-colonelcy of the 69th regiment, he returned to England, but finding that that regiment had meanwhile been sent to Jamaica, he was obliged to repair to that island in the following year. The corps of which Sir Thomas thus took the command appears to have been brought by carelessness and inefficiency on the part of its previous commanders into a very disorganised condition, from which it was speedily redeemed under the management of Brisbane, and this so effectually as to secure for him the highest encomiums of Sir George Nugent, then governor of Jamaica.

Sir Thomas Brisbane's health having suffered severely from the effects of climate, he was obliged to retire on half-pay, when in 1804 his regiment was ordered to India. But in 1810 he was appointed to the staff at Canterbury as assistant adjutant-general; and on the army going out to Portugal, he applied for an appointment under his old friend Sir Arthur Wellesley. In 1812 he secured this great object of his ambition, and as brigadier-general joined the head-quarters of the army then at Coimbra. "The Duke," says Sir Thomas, "received me with the utmost kindness, and said he was glad to see me, as he had two brigades vacant for me."

Sir Thomas remained in this high command throughout the remainder of the Peninsular war, and for his distinguished services, especially at the battle of Orthes on the 27th February 1814, he had the honour of receiving by name the thanks of the British Parliament.

At the close of the Peninsular war, Sir Thomas Brisbane was selected for the command of one of the brigades which were then sent out to Canada, where he used his influence in putting an end to the barbarous practices too often resorted to by both parties in the unfortunate war with America. The escape of Napoleon from Elba recalled Sir Thomas in haste to Europe, where, however, he arrived too late to take part in the final triumph of his great Commander. It is interesting to read Sir Thomas's account of the Duke's language when twelve fine fresh regiments of his best and oldest troops joined him at Paris. Looking down the lines of nearly 5000 men each, the Duke exclaimed, "Had I had these men at Waterloo, I should not have wanted the assistance of Prussians."

There is one curious incident of this period of Sir T. Brisbane's life which is specially interesting to us. It is well known how intense was the feeling of bitterness against the French government and people roused in the German nations by the cruel humiliation they had all successively undergone from the successful tyranny of Napoleon. Some of the public buildings of Paris, commemorative of his victories, were saved only by the personal interference of the Duke of Wellington. It appears that another, the abode of no less celebrated a body than the Institute of France, was saved through the appropriate agency of Sir T. Brisbane. The claim thus established on the favour of the most distinguished scientific society in the world, in addition to that founded on his own acquirements and pursuits, was speedily acknowledged. On the motion of Bouvard, the French astronomer, Sir Thomas Brisbane's name was added, by an unanimous vote, to that roll of membership, which affords, and has long afforded, one of the most valued honours attainable by the successful cultivators of science. It is impossible not to be reminded by this circumstance of that other not dissimilar reward which Milton, in the proud consciousness of his own immortal powers, promises to him who should defend and spare his house from the dangers of a captured city:—

"Captain, or Colonel, or Knight in arms,
Whose chance on these defenceless doors may seize,
If deed of honour did thee ever please,
Guard them; and him within protect from harms.
He can requite thee, for he knows the charms
That call fame on such gentle acts as these;
And he can spread thy name o'er lands and seas,
Whatever clime the sun's bright circle warms."

No better tribute can be rendered to the military character and abilities of Sir T. Brisbane, whose active professional career closed with the end of the war in 1815, than that rendered by the Duke of Wellington in an answer which is recorded by our late President himself. "On my return from America, the late Major-General Sir Manby Power, and the late Lord Kean, informed me that they had written to the Duke of Wellington at Brussels, offering themselves for employment in the army which he was forming for Waterloo. His grace replied that he should be happy to comply with their request, but he could hold out no promise to them until Sir T. Brisbane had received the division which he preferred. This I learned from the above-named generals, but the duke never mentioned it to me himself."

In 1820 the continued favour of his old commander procured for him the governorship of the important colony of New South Wales. It was this command at the Antipodes which enabled Sir Thomas to render to astronomical science those new and important services which procured for him, four years after his return, the gold medal of the Royal Astronomical Society of London. He established, and maintained entirely at his own expense, the now celebrated observatory at Paramatta. So early as 1808, when his health had compelled him to retire for a time from active service, he had erected an observatory at Brisbane, his native place; and some of the instruments procured for this establishment were the first with which observations were begun at the Antipodes.

I am indebted to my friend Principal Forbes for an interesting note on that portion of Sir T. Brisbane's life which bears most closely on his connection with this Society.

"Sir T. Brisbane was elected an F.R.S.E. in 1811, but in consequence of his various military appointments abroad, he did not personally take much part in its proceedings until about 1826, when his name appears on the list of the Council. He had, however, manifested his warm interest in the Society by the contribution of several papers connected with his favourite subjects of Astronomy and Meteorology. In 1832 he succeeded Sir W. Scott as President of the Society, an honour which he fully appreciated to the very last. While his health remained tolerably good, he took a very active and warm interest in the proceedings of the Society, and to his considerable personal inconvenience he, for many years, came by coach from Kelso to Edinburgh, on the first Monday of every month during the winter, when he attended the Club dinner, and afterwards presided at the evening Meeting.

"A certain simplicity of character, combined with a dignity and courtesy which peculiarly became him, made him deservedly and universally popular among the fellows. The perfect disinterestedness with which he devoted himself to science, added to this favourable impression a feeling of sincere respect. He was lavish of money when any scientific object was in view. Many an unfriended but ingenious person has been encouraged by his liberality, which only erred sometimes on the side of being too indiscriminate.

"Sir Thomas may be said to have spent, not one, but several fortunes in the cause of science; and all the while his personal habits were of the most simple and unpretending kind. About seventeen years ago, having fallen heir to a considerable property, his first thought was how to spend it best for the advancement of his favourite sciences. After consultation with one or two persons on whose judgment he relied, he determined on erecting the magnetical and meteorological observatory at Makerstoun, and on supporting the needful staff of observers at his own expense.

"The valuable observations which were made there, most ably superintended, for the most part, by Mr J. Allan Brown, were afterwards printed at great length in the Transactions of the Society, at the joint expense of the Society and of Sir Thomas himself. The value of these records—extending to three thick quarto volumes—will be hereafter even more appreciated than they are at present. They form probably the greatest contribution made to science by Sir T. Brisbane; hardly even excepting the establishment of the Australian Observatory. They have a double interest for us, as being a unique contribution to the science of his native country: and he was liberally anxious that the Royal Society should be so far associated with him in this truly patriotic work.

"The Society has striven to show how much they appreciated the zeal of Sir T. Brisbane in this matter by taking the initiative in providing for the publication of the final, but less continuous, observations, both magnetical and meteorological, which were made at Makerstoun subsequently to the year 1846, with which the records contained in Vol. XIX. of our Transactions terminates.

"Sir Thomas, as usual, entered warmly into the scheme, and defrayed an equal share of the expense. A great part of the proof sheets were put into his hands not long before his death; and it will be with a melancholy satisfaction that the fellows will receive, on this first anniversary meeting since his death, the fasciculus containing the last bequest to science of our late eminent and disinterested President.

"It would be unjust to Sir Thomas Brisbane's memory not to add, that when from increasing weakness and disease he became wholly incapable of attending the meetings, he, not once, but repeatedly, placed his resignation in the hands of the Council. But they, acting as just interpreters of the feeling of the Society on each of those occasions, besought the veteran general to remain at their head, confident that, in heart at least, he was as devoted as ever to the cause in which they, as well as he, had laboured."

For myself, I must express my great regret that I have never had the honour of knowing, or even seeing Sir Thomas Brisbane, and that therefore I have no means of speaking, except on the authority of others, of those personal qualities which are alluded to by Principal Forbes in the passage I have now read. But from other sources I know enough of the incidents and tenor of his life to entitle me to say that, eminent as Sir T. Brisbane was as a soldier and as a man of science, he was not less remarkable for the benevolence of his heart, and the highest virtues of the Christian character.

Among the Fellows of this Society whom we have lost during the present year, there is another whose name I cannot pass by in silence, or with mere mention only, I mean the name of Mountstuart Elphinstone. In all probability there are few members of this Society now present to whom this distinguished man was personally known: because the greater part of his life was spent in India, and the remainder of it in very close retirement. But his name is familiar to all of us as one of the most eminent among those whose courage and ability have built up the colossal fabric of our Indian empire. So far as active service is concerned, he was a yet earlier companion in arms of the great Duke than Sir Thomas Brisbane. Alternately acting as soldier and civilian, as in the earlier days of the "Company" all her great servants occasionally did, he took an active part in the campaign which founded the fame of Arthur Wellesley, and, to use the striking words of Lord Ellenborough on a late occasion, "He saw on the field of Assaye the promise of the field of Waterloo."

Mountstuart Elphinstone has, however, a higher claim on the grateful recollection of his country. When war had done its work, and the time had come for governing the people who had been conquered, his powers of administration were as conspicuous as his courage in the field. By the universal consent of all who know the history of our Indian empire, he is regarded as one of the very greatest of those whose wisdom and virtue have tended to reconcile its people to British rule, and have founded those traditions of government which, modified more or less by the progress of events, must continue in the main to be the guide, not only of us in India, but of all nations who undertake the difficult and responsible duty of ruling other nations, different from themselves in race, language, and religion.

George Buist, LL.D., F.R.S.S. L. and E., and G.S., another recently deceased fellow of the Society, was born at Tannadice in the year 1805. His father having been minister of that parish, which is in the presbytery of Forfar, Dr Buist was educated at St Andrews, and studied divinity for the purpose of becoming a minister of the Church of Scotland; but, though licensed to be a preacher, he never was ordained as a minister of the Church. He cultivated with assiduity the study of science, especially in its bearings on natural history and geology, founded a provincial society for its prosecution, and gained the prize offered by the Highland and Agricultural Society for an account of the Geology of Perthshire, which is published in the Transactions of that Society. During his residence in India he contributed many papers of interest to the scientific societies of that country. In addition to these, he also published papers of interest on its antiquities and history. Many important public works enjoyed much benefit from his active co-operation. Among these may be mentioned the establishment at Bombay of an industrial school for natives, wherein a knowledge of British manufactures was taught, and which led the way to similar industrial institutions for the other presidencies. His energy and abilities were appreciated by the Indian Government, notwithstanding that he was in frequent political opposition to it; and when the superintendence of the government printing-press and government *Gazette* at Allahabad became vacant, Dr Buist was appointed to it by Lord Canning. Dr Buist died on a voyage to Calcutta, on the 1st day of October last.

I wish I were capable of presenting to the Society anything like a really useful review of the progress of science during the year which is about to close. This I cannot pretend to do; but perhaps I may be allowed to direct your attention to one or two subjects to which that progress has been important.

To begin with our own country, and with an investigation the importance and interest of which has been acknowledged by the Society in the grant of the Brisbane medal,—I have reason to believe that Sir Roderick Murchison has been prosecuting with farther success his examination and reclassification of the more ancient rocks of Scotland. The clue afforded some years ago by the discovery of Mr Peach, that the limestones of Duirness in Sutherland contained fossils of the Lower Silurian age, has been followed up by our distinguished countryman Sir Roderick, with his usual indefatigable perseverance, and his usual sagacity of interpretation. The result of his last researches goes far to extend the light already thrown on the rocks of Sutherland and Ross to the vast series of micaceous and quartzose strata which constitute the great bulk of the Western Highlands in the counties of Argyll and Inverness. And I think it a circumstance worthy of mention, that some years before the discovery of the Sutherland fossils, and before, therefore, any clue from organic remains had been afforded, Sir Roderick Murchison had suspected that the whole series of metamorphic slates in the district to which I refer were nothing more nor less than altered strata of Silurian age. He expressed that suspicion strongly to myself in 1850, when I had an opportunity of pointing out to him some of the more characteristic beds in the neighbourhood of Inveraray. During this last summer and autumn, he has traced the upward series of rocks from what he calls the fundamental gneiss in Sutherland and Lewis, southward to the islands of Islay and Jura, and by a close examination of the stratigraphical relations, is now prepared to furnish proof of the truth of the conclusion to which by a species of instinct he had been led before. In one of the facts upon which this determination rests, I think I can venture, from personal observation, to confirm his argument. The term gneiss had been correctly applied by M'Culloch to the fundamental rock of the outer Hebrides, a rock which reappears in great mass on the south-west coast of Sutherland. But unfortunately he applied the same term to other rocks, which are now proved to overlie beds containing Lower Silurian fossils. He thus confounded strata which are separated by immense ages from each other. Now, Sir Roderick Murchison has pointed out the essential differences of lithological character which distinguish the fundamental gneiss from all the rocks of the overlying series. When these differences are once pointed out, it is impossible to mistake the two. The fundamental gneiss is distinguished by the predominance of hornblende, so thickly laid, generally in lines parallel to the stratification, as frequently to render the stone almost black. The felspar and mica are generally found in large separate crystals and plates; and it is not unfrequently intersected by veins and masses in which the same mineral constituents are more perfectly mixed in the form of granite.

To this rock, which is largely developed in our North American possessions, where also it is succeeded by a very similar series of overlying deposits, the term "Lawrentian" has been applied by Sir William Logan.

This term Sir Roderick Murchison proposes to retain for the oldest stratified rock yet known in the world. Upon this fundamental Lawrentian gneiss are piled the vast series of Cambrian strata which constitute the great mass, and sometimes the whole, of the most striking mountain-forms on the west coast of Sutherland and Ross. These strata are estimated by Murchison to measure some ten or twelve thousand feet in thickness. Resting again unconformably upon these Cambrian beds, and capping with their white quartzites many of the mountains, the true Silurian rocks appear, distinguished—mainly in the limestone bands, but also, though more rarely, in the quartzites—by orthoceratites, and other characteristic fossils. Intercalated among these, and therefore having their relative age clearly determined, occur those other more crystalline and metamorphic strata to which the same term gneiss had been also unfortunately applied. But no two rocks can be more different than those overlying rocks from the fundamental gneiss. I have never seen in any part of the South-west Highlands, among the mountains which M'Culloch assigns to gneiss, any rock approaching in character to the gneiss of the Hebrides and of the north. The question, however, will, I have every reason to believe, be finally settled by the proofs which are about to be brought before the Geological Society. Sir R. Murchison has found that the islands of Islay and Jura present perfect repetitions of the phenomena of Sutherland, and that the quartz rocks and limestones of Silurian age are superposed conformably and without a break by the micaceous and chloritic series which occupies such large tracts on the opposite mainland, and which, folding over a little south of Loch Tay, and clasping round Schiehallion, again rises up to the north of Loch Rannoch, and allows the lower quartzites and limestones to reappear. Very curious questions arise as to the causes of the metamorphic action which has so completely altered the structure of beds lying over others which remain comparatively unaffected. Some geologists have been inclined to deny the existence of true stratification in the micaceous chloritic schists of the South-west Highlands, and to assign the appearances to lamination or slaty cleavage. I must say I agree entirely in the view taken by Sir R. Murchison, that this doctrine is wholly untenable. Indeed, I can with difficulty suppose its being held by any one who is familiar with the districts in which these rocks prevail. It may safely be affirmed that there is no one indication or feature of true aqueous stratification which is awanting, except the presence of organic remains. There are the same alternations of siliceous, muddy, and calcareous beds, which everywhere characterise a long continuance of marine deposit thrown down under various mineral conditions.

It is well to observe that this new classification of the rocks in the north-west of Scotland adds additional force to an argument long ago used by Sir Roderick Murchison in reference to the bearing of geological evidence on the great question of the beginning and succession of life. The Silurian strata, in which fossils have been discovered, are more crystalline and more highly metamorphic than the Cambrian strata which lie below them. Yet, in Scotland at least, no organic remains whatever have as yet been discovered throughout the vast series of beds which belong to those old deposits; whilst elsewhere the few forms of life hitherto discovered indicate what M. Barrande has called a "Primordial Zone." These successive formations have now been traced, and more or less examined, in almost every region of the globe, and everywhere the same limited assemblage of organic remains has been established—the same total absence of any indication of terrestrial life—the same few generic types, chiefly of crustacea, cephalopoda, brachiopoda, most of which have long since ceased to be, whilst one at least has survived every subsequent revolution, and is still living in the present day. On the other hand, it will no doubt be argued by those who take an opposite view, that the circumstances attending this reclassification of the older rocks of Scotland tend more than ever to teach the necessity of caution in the interpretation of negative evidence. The abundant existence, it will be said, of organic life during the ages of the Silurian deposit is beyond question. Yet all traces of it have been obliterated absolutely throughout a vast series of beds: in others, the indications are so exceedingly obscure that their character is altogether doubtful; whilst only in one or two thin seams of limestone, and in still rarer quartzite beds, has an unequivocal record been preserved of the highly organised and abundant molluscan life of the Silurian seas.

Before passing from the Geology of Scotland, I must direct the attention of the Society to the very beautiful geological map of this city and its vicinity which has been lately published by the Department over which Sir R. Murchison presides as Director-General. The coal-basin, with its coal crops and faults, was the work of Mr Howel; the rest was surveyed by Mr Geikie; both these gentlemen being geologists of the Government Survey. The admirable care and exactness with which they have given the minutest details of a very varied and intricate district, is an excellent example of the high economical as well as scientific value we may anticipate of the geological survey of the country.

The oldest formation in this sheet is the *Lower Silurian*, of which two small patches occur along the southern edge of the map. They belong to the great Silurian tract of southern Scotland, against which the upper Old Red Sandstone and carboniferous rocks of the Lothians rest unconformably. There are at present known only two areas of *Upper Silurian* strata in Scotland, of which one occurs in the Pentland Hills, and is mapped in the present sheet. It consists of highly inclined shales and sandstone. Mr Charles Maclaren was the first to detect organic remains in these strata. About twenty-five years ago he found two orthoceratites, but in a fragmentary state. In the year 1857, when the Geological Survey extended into the district in question, Mr Geikie first made known the richly fossiliferous character of these Silurian strata, the assemblage of fossils unequivocally indicating the horizon of the Ludlow rocks of England. On the edges of the upper Silurian beds rest unconformably the upper Old Red Sandstones and conglomerates, with enormous interbedded sheets of felstone, which form the chain of the Pentland Hills.

The great Lower Carboniferous group is well shown in the area embraced by the present map. It occupies the whole of the district between the Bathgate hills and the Pentlands, and contains in that region a seam of limestone, which is the equivalent of the Burdiehouse limestone on the east side of the Pentland ridge, and also a seam of coal that appears to be quite local. The line of outcrop of these two seams, as traced on the map, will show the intricate character of the geological details. Perhaps the most remarkable feature in the Lower Carboniferous series of the Lothians is the abundance and variety of its associated contemporaneous igneous rocks. There is no well marked zone in the series which does not at some locality in this region display its sheets of greenstone, felstone, or ash.

The Carboniferous limestone of this sheet shows characteristically the Scottish type of that sub-formation. Its base consists of limestone bands, with associated shales, sandstone, and coals. Above these comes the group of coal-bearing strata, known as the "Edge coals" of Midlothian. But these are not the Coal-measures of England, seeing that above them there are bands of limestone, with true Carboniferous limestone fossils. The Millstone grit has not yet been satisfactorily determined, but its place may be represented by some of the thick sandstones of Roslin.

The Coal-measures proper, or "Flat coals" of Midlothian, occupy the centre of the Edinburgh coal-basin. They are truly the equivalents in position as well as fossils of the Coal-measures of England.

It is deserving of remark, that while, in the Lower Carboniferous strata and in the "Edge-coals" of Linlithgowshire, volcanic rocks abound, none occur in the Edinburgh coal-field, although they were abundant in that district during the earlier part of the Carboniferous period.

The system of parallel faulting of the Pentland Hills is also worthy of notice, as accounting for the small development of Lower Carboniferous strata on the east of the chain, and their great expansion to the west. The highly inclined character of these strata along the east side of the hills (some being quite on edge, hence called "Edge-coals"), arises from the downthrow of the whole coal-field against the older rocks of the chain. A detailed description of the sheet from the geologists before named is at present in the press.

The attention, not of geologists only, but of men of science in several departments, has, during this and the preceding year, been fully awakened to the importance of a discovery which is really of much older date—viz., that flint implements, the work of man, are found in beds of drift gravel associated with the bones of the last generation of the great extinct mammalia. The full significance of this fact is only now being fully recognised, and many of the conclusions which it may tend to establish are subject to much doubt, and will probably form the subject of increasing controversy. But it is only necessary to have a clear idea of the facts as they have been now ascertained, to see that one conclusion at least is placed beyond all question—viz., that great physical changes on the surface of the earth, and these, in part at least, effected by the agency of water, have taken place since the creation of man.

Whether this conclusion carries the creation of man farther back than had commonly been supposed, or whether it merely brings nearer to us than we had before conceived, the last great changes which have produced the existing surface, is the main question on which debate arises. As geology gives no certain data for computing positive, but only relative time, this question is necessarily involved in much obscurity. But there are certain limits within which, after all, the controversy is confined. It is well to observe that, according to the principle on which geological times and epochs are classified, the human epoch remains, after these discoveries, very much where it stood before. It is true that many of the large animals, with which the traces of man seem to be connected, are now extinct; but a very much larger number are still living. The

Molluscan Fauna, which plays so important a part in ages of geologic time, is absolutely the same. The general aspect of animal life is the present aspect, with the exception that a certain number of species of the larger Herbivora and Carnivora have become extinct. But such extinctions, local in many instances, and total in some, have taken place in historic times, and are in visible process of accomplishment even now. Such extinctions do not constitute a new Fauna, nor, according to the received principle of classifying past times, do they mark a new geological age. The era of man, therefore, remains, geologically speaking, in the same relative place in which it stood before—the very last and latest of the world.

But the fact that human implements are found under great beds of gravel and of earth formed by water, whether of rivers or of the sea, at an elevation which in either case would imply changes of level, such as, if general, would be enough to revolutionize the whole aspect of our now habitable surface, is a fact which casts new and important light on the (geologically speaking) very recent date at which those changes have taken place.

Whether the men who formed the implements were or were not contemporary with the living quadrupeds whose bones are associated with these implements, seems to me a subordinate question. The mere fact of such association may not absolutely prove the point, because it is conceivable that the bones may have been merely reaggregated from an older fossiliferous deposit. But I suspect that the reluctance to admit the contemporaneity of man with those animals results from the reluctance to admit man's priority to such physical changes as are supposed to separate us from a Fauna typified by the Mammoth and the Elk. If, therefore, the fact of such priority be proved from the stratigraphical position of the flint relics, wholly independent of any argument derived from organic remains, the importance of the question respecting the human age of the great mammals will be much diminished. It may be well, therefore, to keep our attention firmly fixed on what is the really important question—the nature and position of the strata in which, and under which, the flint implements have been interred. Going no farther for light upon this question than the particular beds at Amiens and Abbeville in France, where the implements have been found in greatest abundance, it is enough to record the facts. The flints are embedded in a stratum of gravel, which rests directly on an eroded surface of the chalk, and contains along with the hatchets the bones of the great extinct mammalia. This is again surmounted by a bed of sand from seven to ten feet thick, in which only a few rare bones and implements have been found. This is again capped by a second bed of gravel from two to five feet thick; and lastly, on the top of all, is a bed of brick-earth, in which, as if to afford the very poetry of illustration, are to be seen the tombs of Roman Gaul. Such is the position of the beds with reference to each other. But what is their position with reference, not to each other, but to the surrounding country? The gravel-bed extends to points upwards of a hundred feet above the level of the river Somme, which occupies the bottom of the existing valley. It is described by Professor Rogers, a most competent and accurate observer, as extending to the summits of the plateaux which determine the existing drainage. Whether, therefore, the water which formed those beds were marine or fluviatile, in either case such changes of level are implied as would be sufficient, if general, to alter widely the existing distribution of land and sea.

Here, then, the question arises, Were those changes local—confined perhaps to the district of Western France? Connected with this question, another immediately occurs: Is not this bed of gravel identical in character and composition with similar deposits in other countries? Is there anything to distinguish it from the gravels containing precisely the same mammalian bones which are familiar to geologists in almost every country, and which have been recognised every here and there over the whole of Europe, from Siberia to Palermo, and from the basin of the Thames to the valley of the Danube? So far as I have been able to gather from the papers which have detailed the facts, there is nothing to indicate any difference whatever, except that, at least until this discussion arose, human implements had nowhere else been recognised as associated with the drift. The absence of such remains elsewhere, however, would go for little in establishing a difference, because it is clear that the men who existed before the formation of the Abbeville beds were rude, and probably widely scattered savages, distant outliers of their race. The chances, therefore, were infinite against the preservation either of them or of their works. But even this distinction, it would appear, is being broken down. It is now recollected that so long as sixty years ago, human implements had been discovered in Suffolk under similar conditions, and the fact communicated to the public in an archæological journal by the discoverer Mr Frere. The spot has been since visited by Mr Prestwich, fresh from the Abbeville beds, and he recognises the same phenomena. But this is not all. The scent, once taken up, is becoming stronger and stronger, every day. Closely connected with the period of the drift-gravels are the ossiferous caves and caverns so common all over Europe where limestones prevail. They have been long known to contain a profusion of bones of the extinct as well as of living mammalia. Here, again, it is now confidently asserted that human implements are being found under conditions which leave no doubt that, whether man was or was not contemporary with these animals, he must at least have preceded the action of those agencies which brought the bones together. The evidence in this case must necessarily be more liable to erroneous interpretation than in the case of implements found in undisturbed beds of gravel, because caverns must at all times have been a resort of savage tribes whenever the entrances were accessible from the surface. But the evidence seems to be such as is sufficient to convince examiners so careful and acute as Dr Falconer and Mr Prestwich of the undoubted priority of man to that diluvial action which appears to have swept into those caverns their mixed contents. But this is not all. It is now recalled to mind, that so long ago as 1833, a M. Schmerling had published Researches into the Ossiferous Caverns of Belgium, in which, not implements of man only, but his teeth and his bones, and portions of his skull, had been found so thoroughly mixed up with the remains of the lower mammalia, as to leave in his mind no doubt, if not of their contemporaneous life, at least of their contemporaneous entombment in the spots where they are now found. These are remarkable facts; and in so far as they indicate that the phenomena of Abbeville are closely related to others observed in many different parts of Europe, they go far to prove that the French gravel-beds were due to no mere local cause, but to some diluvial action which was general, and therefore in all probability due in great part to the waters of the sea.

I need not point out how many and how interesting are the questions which this discovery raises in our minds. Was this incursion of the waters of the sea, over a pre-existing land, sudden and transient, or gradual, and of long duration? In the Abbeville beds there seems to be clear evidence of four successive stages of submergence, each distinguished from the other by different mineral conditions. The first bed, that in which the bones were entombed along with the human implements, indicates an action strong, if not violent, but not of long duration. The second indicates, by its finer materials, the action of a gentler force. The third seems to be very much a repetition of the first; whilst the last can only be accounted for on the supposition that fine sediment had time to accumulate in comparatively tranquil waters. The interest of the question is very much centred in the nature of the action which began this series of events. Perhaps it may be well to look at the conclusion come to in respect to the origin of the mammaliferous drift-gravel by the geologist who has devoted most special attention to the subject, and before the discoveries of Abbeville had disturbed any preconceived idea. I find Mr Prestwich, in a lecture delivered in 1857, coming to this conclusion in respect to the ossiferous gravels of the Thames:—"Taking into consideration the absence of contemporaneous marine remains, and noting the immense mass of but slightly worn débris derived from and covering irregularly the sedimentary deposits; and the fact that it has evidently been transported from greater or less distances, combined with the occurrence in the gravel of the remains of large land-animals, of trees, and of fresh-water land-shells, we have, I conceive, at all events in these facts, indications of at least one land-surface here destroyed, and its rocks, plants, and animals involved in one common wreck and ruin."

An able and elaborate paper on the "Distribution of the Flint-Drift of the South-east of England," &c., was communicated to the Geological Society of London by Sir R. Murchison in 1851. The phenomena he describes seem everywhere to be a precise repetition of those of Abbeville. Everywhere the flint-drift, which is often, as there, covered by brick earth, clay, or loam, is characterised by the bones of the great extinct mammalia, and everywhere, according to the author's view, gives evidence of sudden and violent diluvial action. Everywhere, also, this drift-gravel rises high above the levels of the existing drainage, whilst, at the same time, it gives evidence that the general configuration of the surface was substantially the same as now. Everywhere, also, wherever shells have been preserved, they belong to our existing fauna, and thus prove beyond a doubt that, geologically speaking, the age of the drift is the age of the existing world. "In short," he says, "the cliffs of Brighton afford distinct proofs that a period of perfect quiescence and ordinary shore action, very modern in geological parlance, but very ancient as respects history, was followed by oscillations and violent fractures of the crust, producing the tumultuous accumulations to which attention has been drawn."

Unless, then, the Abbeville beds of drift can be separated from those so widely prevalent in other countries, the discovery of human implements underneath this drift will rather tend to bring nearer to us than had ever been supposed some great and sudden diluvial action, than to cast any very clear light on the absolute time—that is, on the time measured by years or centuries—which has elapsed since the creation of our race. The facts which have been brought to light prove, indeed, clearly enough, that since man walked the earth some great changes have affected the condition of its surface; and it is impossible as yet to say what bearing this discovery may be found to have on that remembrance of at least one great catastrophe, which is not more a part of sacred history than it is of profane tradition.

We must not, however, shut our eyes to the indirect effect which this discovery must have on the question of positive time. In the first place, there is a school of geologists, led by our distinguished countryman Sir Charles Lyell, who disbelieve generally in those conclusions which point to violent and sudden changes; and, in the next place, it must be remembered that changes which in point of geological time might well be accounted rapid, might nevertheless well occupy thousands of our years. There is proof in those gravel-beds of the Somme of a double motion, one of submergence to the depth of certainly more than 100 feet, another of subsequent elevation, during which the immense mass of material which had been brought down and deposited by water, has been worn through and broken into escarpments, either by the existing stream or by more powerful currents. We have no data from which to measure in years the time which the accomplishment of such a series of changes may imply. But I think the general impression left upon the mind must be in favour of a very high antiquity. Farther light may be cast upon this subject if the drift-gravels of France, the south of England, and other countries, can be co-ordinated with any one of the stages of operation to which we owe the superficial deposits of Scotland and the north of Europe generally. It is well known that in these last there is one prominent characteristic which is absent farther south. I mean the abundant proofs of glacial conditions, or an arctic climate. On this subject there is a paper of great interest in the last "Quarterly Journal of the Geological Society," by Mr Jamieson, founded on observations made mainly in the county of Aberdeen. The cycle of changes which this geologist thinks can be clearly traced, as necessary to account for the superficial deposits of our own country, amount to no less than five great epochs, including two of submergence and two of elevation, and involving changes of level to the extent of more than 2000 feet. Scotland has long ago furnished evidence as clear as that founded on the French flint implements, that at least previous to the last of these elevations man had reached her shores, and navigated her rivers and estuaries in those rude canoes, hollowed out of trunks of oak by stone hatchets, which have been frequently found in elevated beds of silt and gravel in the valley of the Clyde. And here we strike upon evidence which has some bearing upon the question of time. Closely connected with the period preceding the last elevation of the land, we have proof that an arctic climate prevailed over a large part of the northern hemisphere, whose climate is now comparatively temperate. But this period seems clearly to have been one of long duration—that is to say, of such duration, and lasting under such conditions of comparative rest, as to allow the development of a glacial fauna. Close to my own residence on the Clyde, each low ebb exposes numerous examples of the *Pecten Islandicus*, and of those very large *Balani*, which are now confined to arctic seas. These beds of shells, which are all of existing species, but of species which have retired from our now more genial temperature to a northern habitat, were first described by my friend Mr Smith of Jordanhill, and his observations and conclusions have since been abundantly confirmed. We have no knowledge how this period was brought to a close. But there seems to be evidence that it had come to an end, and that for a long time before the last elevation of the land, and before man had appeared in Scotland. This seems to be a legitimate deduction from the fact that the canoes in the elevated Clyde beds are formed of oak of large dimensions and of great age. Forests which afforded such timber must have flourished in a climate not much more rigorous than that which exists at present. Here again, then, the earliest footprints of our race are traced up to a point, preceding indeed some important physical changes, but clearly subsequent to the establishment of all the main conditions which now affect the distribution of animal and vegetable life.

As regards the extinction of some animals, I have spoken as if the contemporaneousness of man with them whilst yet living ought not to be absolutely assumed merely from the fact that his implements are associated with their bones. But on this point new evidence is being rapidly collected and brought together. Mons. Lartet, a distinguished French naturalist, has found what he considers to be distinct evidence of the mark of human weapons on various parts of the skeletons of the extinct mammalia of the drift. These marks have been detected on the skull of the *Megaceros Hibernicus*, or great Irish elk,—an animal which stood some ten feet high—on the bones of the *Rhinoceros tichorinus*, and on those of various species of the ox and deer, which are now either extinct or confined to the last remnants of a declining race. The marks are of various kinds—some of them peculiar—indicating a sort of sawing with some instrument not of the smoothest edge. M. Lartet has ascertained that these blows and cuttings could not be made except on fresh bones—that is to say, on bones undried and retaining their animal cartilage. Farther, he has succeeded in producing on the bones of existing animals precisely the same peculiar forms of incision by using one of the old flint implements found in the same beds of gravel, whilst he has equally found that similar marks are incapable of being produced by implements of metallic edge. His conclusion is thus stated by himself:—"If, therefore, the presence of worked flints in the diluvial banks of the Somme, long since brought to light by M. Boucher de Perthes, and more recently confirmed by the rigorous verifications of several of your learned fellow-countrymen, have established the certainty of the existence of man at the time when those erratic deposits were formed, the traces of an *intentional* operation on the bones of the rhinoceros, the aurochs, the megaceros, the cervus sommensis, &c. &c., supply equally the inductive demonstration of the contemporaneousness of those species with the human race."

The great number of flint implements which have been found in the French beds—said to amount to upwards of a thousand in a few years—when compared with their great rarity elsewhere, is not perhaps so curious as at first sight it may appear to be. Flint implements can only be made where flints are accessible; and it is well known that the flints of particular beds, or strata, of the chalk, are more easily fashioned than others. It is therefore probable that some such favourable locality had existed in the chalk of that part of France, and that what may be called a manufactory of them had consequently been established there. It is remarkable that some of the implements are only half finished, whilst all of them exhibit such sharp edges and angles as are sufficient to prove that they have not been transported far from the spot where they were made, nor subjected to long wear from use.

On the whole, then, it is not to be doubted that the discovery of human implements under repeated beds of aqueous drift and sediment, so high above the levels of existing rivers, or of the existing sea, is a fact of very great significance and importance. In its bearing on geology, it is principally interesting as proving at how recent a period portions at least of the earth have been subject to powerful and rapid diluvial action. In its bearing on human chronology, everything depends on the degree of suddenness and rapidity with which water may have been brought to act upon the former surface. But here anything like data for positive computation entirely fails us. We have no knowledge, in historic times, of any aqueous operation on so grand a scale. Making, however, every deduction which can be made, we must be prepared to find that the facts thus brought to light in the valley of the Somme will be held to furnish important collateral evidence in support of the reasoning founded on other sciences, such as philology and ethnology, which has long demanded, for the development of our race, a number of years far exceeding that which is allowed by the chronology previously received. It is the beautiful expression of Sir Thomas Browne, which I find quoted by Dr Mantell in a former paper on this subject, that "Time conferreth a dignity upon the most trifling thing that resisteth his power;" and it is impossible to look at these rude implements—perhaps the earliest efforts of our race, in the simplest arts of life—without being impressed with the high interest of the questions with which they seem to be inseparably connected.

I think it is impossible not to consider the publication of Mr Darwin's work on the "Origin of Species" as an event in the history of scientific speculation. The influence which such theories have had in stimulating and directing the progress of actual discovery, entitles them, when they come from distinguished men, and when they rest on any large amount of careful observation, to the marked attention of such Societies as this. It cannot be denied that Mr Darwin's book claims our respect on both these grounds. It may be true, as I think it is, that all the facts he has brought together, supposing them to be clearly established (or even much extended by the volume of proof which is still in reserve), bear a very small proportion to the purely speculative conclusions which go to make up his theory on the "Origin of Species." Yet probably there is no other man now living who could have made such a rich collection. No other man since the death of Humboldt has had such powers of observation, combined with such opportunities of observing. "The Voyage of the Beagle" shows how large and wide has been his experience of the general aspects of nature; whilst his monograph on the Cirripedes, and other papers on zoology, testify to his unwearied assiduity in the examination of detail. His book, therefore, comes before the world with every claim to respectful consideration which can be founded on the high scientific reputation of its author. The "Origin of Species," however, means nothing less than the method of creation; and this is a subject so profoundly dark, that no amount of existing knowledge can enable any man to do more than walk carefully round its outer margin, noting where, here and there, some fact, more significant than others, seems to give hope of entrance into the obscurity within. The particular theory advanced by Mr Darwin is but a special form of the old theory of development; special in this respect, that it professes to point out the particular law under which every animal and vegetable form may have been derived from those pre-existing, by ordinary generation. One general admission may, I think, be safely made in reference to all such theories. They are undoubtedly more easily conceived than what is called "creation." But this is not saying much. The truth is, that creation, of which we often talk so easily, is a work of which we have no knowledge and can have no conception. Something is known of the laws under which organic beings, once created, are enabled to continue their existence and to propagate their kind; and it is, of course, comparatively easy for us to conceive some such modification of those laws as Mr Darwin suggests,—to suppose that any given animal should occasionally produce offspring slightly different from itself in some one portion of its structure, and that such differences should go on accumulating, until finally they end in the most divergent forms. But to imagine processes which shall be the most easily conceivable goes but a very little way in science; and, after all, the difficulty is but postponed. Mr Darwin himself is obliged to have recourse at last to the ordinary forms of language in which the idea of creation is expressed, and speaks of a primordial form into which "life was first breathed." In science we may sometimes allow the question to be asked, "What is most easily conceivable?" but only on condition that it be followed hard by the farther question, "How much of this easiness of conception is gained at the expense of departure from the evidence of facts and the experience of nature?" In answer to this inquiry, it may well be doubted whether Mr Darwin has proved one single fact capable of sustaining the very first step in his ingenious argument. That argument seems to be as follows: Man has succeeded by "artificial selection"—that is, by careful "breeding"—in establishing certain modifications in the forms of domestic animals. Therefore, similar results may be produced to an infinitely greater degree by nature. Only, the principle of selection will be different. Man chooses those qualities which are most useful to him as master. Nature will choose those which are most useful to the animal itself. But the qualities which are most useful to an animal will be those which enable it to survive when its fellows and congeners die. If, therefore, any such qualities arise in any particular family or breed, they will be preserved and perpetuated. This is a beautiful theory. But when we ask how far the facts carry us towards the "origin of new species," we find that there is in reality no perceptible advance. The changes producible by breeding, or by "artificial selection," are all confined within a circle which indicates a restraining law. The changes producible by "natural selection" are, so far as we know and can observe, under similar, if not under still narrower limitation. As regards the first, Mr Darwin himself supplies us with an illustration beyond all others striking, of that law of reversion to type, the existence of which he nevertheless disputes. Pigeons are his favourite example of extreme modification of form. They have been "bred" or selected for three thousand years. Mr Darwin took two of the unlikest and most aberrant parents he could select, a black "barb" and a white "fantail." The result was, that a grandchild of these parents exhibited a close return to the old primal type, the rock-pigeon, from which all domestic pigeons originally sprung. Yet who knows through how many generations of "selected parents"—perhaps from the days of the Pharaohs—this chick had inherited its ancestral colours! Can there be a stronger illustration of that restraining law of reversion to type, which, so far as we know, confines within a very narrow circle, not only the extent, but the duration of aberrant forms of life? Then, as regards natural selection, do we know of any one authentic instance in which new conditions of life have been met by such modifications of structure as might enable an animal to survive its congeners in the "battle of life?" Our experience in this way is perhaps fully more extensive than in any other. The truth is, that man is himself the greatest modifier of the natural conditions under which the lower animals are placed. He is year by year producing revolutions which might be equivalent to centuries of natural change. Nor are these without a powerful effect on animal life. Mr Darwin has traced the changes thus produced with singular ingenuity and beauty of description. But all those changes are produced by the substitution of one species for another,—never by the modification of the same species to the new conditions which surround it. There need be no dispute that, under the law so beautifully traced by Darwin, such modifications, *if they did arise*, would tend to survive and be perpetuated. But what we want is—facts to justify the supposition that any such modifications do actually arise; such, for example, as would enable an animal adapted for marshy land to survive on land which had become dry;—or arboreal forms to survive the destruction of their native forests;—or land-animals to adapt themselves to a country which is being gradually submerged. These are all operations of which man has had experience, and to some of which he is every day contributing; yet no instance is recorded of nature having ever had any opportunity of exercising in favour of any animal that "selecting" power which is the assumed origin of new species. The Fauna is indeed changed by such changes of condition as I have supposed. But that change is effected by substitution, not by conversion. One animal or plant invades the former territory of another. In our own country, for example, the grouse gives way to the partridge, or the snipe to the landrail; or, more rarely, the lark may be supplanted by the waders and the gulls—the field-mouse and the mole by the water-rat and the otter. But in no case that we know of, or that Mr Darwin has adduced, has any wild animal been enabled, by any modification of form, however slight, to survive any essential changes in that condition for which it was first adapted. And as this is the law which obtains in the present, so also it is the law which appears to have obtained in the past. The absence of any evidence of the passage of one form into another, discoverable in the records of former worlds, is confessed by our author himself. All his arguments are directed, not to deny this fact, but to explain it. It has been truly said, in a very able and interesting paper on the subject which was communicated to this Society by one of its members early in the present year, that "The strongest points in favour of the general results come to by Mr Darwin, are a class of facts which can scarcely be said to bear distinctively on his theory more than upon various other theories already promulgated, and more or less adopted. One of these is the fact that all animals and plants, throughout all time and space, should be related to each other in group subordinate to group, ... another not less formidable fact is the existence of the same homological parts in different animals, sometimes aborted, and sometimes largely developed." The endeavour to explain and account for these strange connections and relationships is one of the highest aims of science. To refer them to the great law of hereditary descent is a very natural suggestion, and for a moment some minds may be disposed to rest in it as a kind of explanation. Reduction to a known and familiar law is the nearest approach to explanation which science can afford. But we must beware of the subtle error which lies in changing a law well known and familiar, into another law entirely unknown and new, by ascribing to it effects and operations of which we have no experience. If the law of descent by ordinary generation is consistent with the origin, through this means, of new species, some proof must be given of the fact. Until such proof is adduced, the assumed law is not that of *ordinary* generation, but of *extraordinary*—of a new kind of generation essentially different from that of which we have any knowledge.

It is well worthy of remark, that Mr Darwin holds strongly to the doctrine of "single centres of creation"—or as, to suit his special theory, they ought perhaps to be called, single centres of birth. He believes that each new species came into being at some one spot only, and that, however wide may be its distribution now, such distribution has been due wholly to dispersion. "If the same species," he says, "*can* be produced at two separate points, why do we not find a single mammal common to Europe, Australia, and South America? The conditions of life are nearly the same." But surely this belief in single centres of creation or of birth is not very easily reconcilable with the rest of Mr Darwin's theory. The essential idea of that theory is, that new species arise from any accidental variety which enables the animal possessing it to have some special advantage in the struggle for existence. But, as similar modifications of structure would in this respect confer similar advantages, at one time or other, under some circumstances or other all over the globe, it is impossible to understand why they should not frequently arise at many different points, either at once, or in succession. We may freely grant, therefore, to Mr Darwin that his reasoning explains to us how a given species, *once born*, and which begins the battle of life under favourable conditions, should rapidly spread, and should extinguish its congeners and predecessors, which are less favourably endowed. But it gives us no sort of explanation, or even suggestion, of the law *under which any such new species is first produced.* How such a new birth comes to be determined, and above all how it can only be determined at some one spot of all the million spots on which the same parents flourish, remains as profound a mystery as before; and we have in reality not advanced a single step towards the "origin of species."

The conclusions arrived at by Mr Darwin are essentially but another form of the old theory of development, and as such they will meet with the same vigorous resistance. We may cordially join in the warning of Professor Huxley, that the arguments of such a naturalist as Mr Darwin must be met on scientific grounds alone. And yet the difficulty, to use no stronger word, of reconciling this theory when applied to man, with all that we know of his physical and moral nature, and all that we have hitherto believed respecting his early history, is at least one among the many difficulties which may well call for the most jealous and critical analysis of every step in Mr Darwin's argument. He himself, indeed, seems to feel no difficulty in the matter—lineal descent from some early fish or reptile—" some ancient prototype furnished with a floating apparatus or swimming-bladder"—Mr Darwin regards as the noblest claim of ancestry. " When I view all beings," he says, " not as special creations, but as the lineal descendants of some few beings who lived long before the first bed of the Silurian system was deposited, they seem to me to be ennobled." I am afraid that the honour of this parentage, as regards our own species, will not be universally appreciated. The question, however, is not whether it be " ennobling" or the reverse, but whether it can be proved or rendered in any degree probable. Yet, in judging of the sufficiency of evidence, it is well to recollect the full weight of the conclusion which that evidence must be strong enough to bear; nor, in this point of view, do I think it wholly unphilosophical to bear in mind the innate beliefs and instincts of mankind.

It is not, however, my duty or my desire, in this place and on this occasion, to enter more deeply into the specific argument on the " origin of species;" I would rather indicate wherein the discussion, and the argument which has raised that discussion, has most directly tended to the advance of science. In this respect, it is not too much to say that the whole book is full of the most curious and original observation, and exhibits in an eminent degree that power and habit of arranging and co-ordinating physical phenomena which is essential to the attainment of great results, and which it has been the special use of such theories in the history of science to evoke and to direct. In particular, I think no one can read Darwin's chapter on the " struggle for existence," or the two chapters on " geographical distribution," without feeling that new and important light has been cast on subjects which are as interesting as they are difficult and obscure.

I hope I need not assure the Members of this Society how highly I value the honour which places me in this chair. To be chosen President of a Society of which the two former Presidents were Sir W. Scott and Sir T. Brisbane is indeed an honour of which any Scotchman may well be proud. But whilst these names are of themselves sufficient to indicate how great that honour is, they are not less sufficient to remind me that your choice of President is determined on different occasions by considerations of very various nature. Sir W. Scott's unbounded literary fame, and the personal affection in which he was held in Edinburgh, placed him in the front of all men who could be competitors for the chair of a Society of which already he was the most illustrious member. Sir T. Brisbane was not only one of the most renowned soldiers of his day, but was besides a man of high scientific attainment, and a promoter of science as wise as he was munificent. I can draw from the choice which you have lately made of a successor to such distinguished men no other inference than that this Society places a very large and generous interpretation upon the qualifications requisite in its President,—that you are willing occasionally to connect the office with those pursuits of public life which, whilst they are unfavourable, I am afraid, to any sustained scientific inquiry, are not incompatible with a sincere interest in the progress of science, and a high appreciation of its value to mankind.

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Report of the Proceedings of Geological and Polytechnic Society of West Riding of Yorkshire. 1859.—*From the Society.*

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Bidrag til kundskab om de Sindssyge i Norge. af L. Dahl. Christiania. 8vo.—*From the Royal University of Christiania.*

The Chronicle of Man and the Sudreys. Edited by P. A. Munch. Christiania, 1860. 8vo.—*From the same.*

Nyt Magazin for Naturvidenskaberne. Vol. XI., Part 2. Christiania, 1860.—*From the same.*

Tabellen und amtliche Nachrichten über den Preussischen Staat. Berlin, 1858.—*From Professor Dove.*

Astronomische Beobachtungen auf der K. Universitäts–Sternwarte zu Königsberg. Parts 31 and 32. 1859. *From the Society.*

Quarterly Journal of the Chemical Society. April.—*From the Society.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome L., Nos. 22–26; Tome LI. Nos. 1–21.—*From the Academy.*

Journal of Statistical Society of London. Vol. XXIII., Part 2. 8vo.—*From the Society.*

La Vérité sur le Choléra-Morbus. Par le Docteur Fremaux. Paris, 1860.—*From the Author.*

Quarterly Journal of Geological Society of London. Vol. XVI., Part 2. 8vo.—*From the Society.*

Address delivered at the Anniversary Meeting of the Geological Society. By J. Phillips, Esq. London, 1860. 8vo.—*From the Author.*

Transactions of the Philosophical Institute of Victoria. Vol. IV., Part 1. 1859. 8vo.—*From the Institute.*

Fragmenta Phytographiæ Australiæ. Parts 8–10.—*From the same.*

Journal of Proceedings of the Linnean Society. Vol. V., No. 17. —*From the Society.*

On the Lower Silurian Rocks in the South-east of Ireland, and on a Human Skeleton in an elevated Sea-margin. By Fort-Major T. Austen, F.G.S.—*From the Author.*

Annual Report of the Royal Cornwall Polytechnic Society. 1859. —*From the Society.*

Proceedings of the Horticultural Society of London. Vol. I., Parts 10–13.—*From the Society.*

Report of the British Association. 1859. 8vo.—*From the Association.*

Jagttagelser over den Postpliocene eller glaciale formation i en del af det Sydlige Norge. Af Prof. Dr Sars og Lector Th. Kjerulf. 4to. 1860.—*From the same.*

Reflexions sur les objections soulevées par Arago contre la priorité de Galilée pour la Double Découverte des Taches Solaires noires, et de la rotation uniforme du Globe du Soleil. Par Jean Plana. Turin, 1860. 4to.—*From the Author.*

Mémoire sur la Théorie des Nombres. Par Jean Plana. Turin, 1860. 4to.—*From the Author.*

Bulletin de l'Académie Impériale des Sciences de St Petersbourg. Tome I., Parts 1–6. 4to.—*From the Academy.*

Mémoires de l'Académie Impériale des Sciences de St Petersbourg. VII^{e} Série. Tome I., Nos. 1–15. 4to.—*From the same.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt. Wien, 1859.—*From the Society.*

Quarterly Return of Births, Deaths, and Marriages registered in Scotland. No. 21.—*From the Registrar-General.*

Mémoires de l'Institut Impérial de France. Tomes XXV. XXVII., Part 2; XXXI., Parts 1 and 2.—*From the Institute.*

Annuaire de l'Institut Impérial de France. 1860.—*From the same.*

Journal of the Asiatic Society of Bengal. New Series. No. 101. —*From the Society.*

Monatsbericht der K. Preuss. Akad. der Wissenschaften zu Berlin. January to December 1859. 8vo.—*From the Academy.*

Memoirs of Geological Survey of India. Vol. I., Part 3. 8vo.—*From the Government of India.*

Abhandlungen der K. Akad. der Wissenschaften zu Berlin. 1854 (Zweiter Supplement-Band) and 1859. 4to.—*From the Academy.*

Proceedings of Royal Geographical Society of London. Vol. IV., No. 2. 8vo.—*From the Society.*

Madras Journal of Literature and Science. New Series, Vol. V., No. 9. 8vo.—*From the Madras Literary Society.*

Journal of Asiatic Society of Bengal, No. 1. 1860. 8vo.—*From the Society.*

Beletin de la Sociedad de Naturalistas Neo-Granadindos, 1860. 8vo. —*From the Society.*

Silliman's American Journal of Science and Art. May 1860. 8vo. —*From the Editors.*

Journal of Agriculture and Transactions of the Highland and Agricultural Society of Scotland. July 1860. 8vo.—*From the Society.*

Bulletin de la Société Vaudoise. Tome VI., Nos. 45 and 46. 8vo. —*From the Society.*

Oversigt over det Kongelige danske Videnskabernes Selskabs Forhandlinger, 1858. 8vo.—*From the Academy of Sciences of Copenhagen.*

Det Kongelige danske Videnskabernes Selskabs Skrifter, 1859. 4to.—*From the same.*

Denkschriften der Kaiserlichen Akademie der Wissenschaften. Band XVII. 4to.—*From the Academy.*

Description of a deformed fragmentary Human Skull, &c. By J. A. Meigs, M.D. 8vo.—*From the Author.*

A Sketch of the Botany of the Great Salt Lake of Utah. By E. Durand. 4to.—*From the Author.*

Acta Academiæ C. L. C. G. Naturæ Curiosorum. Vol. XXVII. 4to.—*From the Academy.*

Descriptions of new Uniones, and other papers. By Isaac Lea, LL.D.—*From the Author.*

Observations on the Genus Unio. By Isaac Lea, LL.D. Vol. VII. 4to.—*From the Author.*

Journal of the Academy of Natural Sciences of Philadelphia. New Series, Vol. IV., Parts 1 and 3.—*From the Academy.*

Mémoires Couronnés, et autres Mémoires, publiés par l'Academie Royale de Belgique. Tome X. 8vo.—*From the Academy.*

Bulletin de l'Academie Royale de Belgique. Tomes VII. and VIII. 8vo. 1859.—*From the same.*

Memoirs of the Literary and Philosophical Society of Manchester. Second Series, Vol. XV., Part 2. 8vo.—*From the Society.*

Proceedings of the Literary and Philosophical Society of Manchester. 1858–59, Nos. 1–16 ; 1859–60, Nos. 1–14.—*From the same.*

On the Phosphates and Arseniates, Microcosmic Salt, Acids, Bases, and Water, and a new and easy Method of Analysing Sugar. By John Dalton, D.C.L., &c. Manchester, 1840–42. 8vo. —*From the same.*

Transactions of the Philosophical Institute of Victoria. Melbourne, 1859. 8vo.—*From the Institute.*

Annual Report of Leeds Philosophical and Literary Society, 1859-60. —*From the Society.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt, 1859. X. Jahrgang, No. 4. 8vo.—*From the Society.*

Sur la Différence de Longitude des Observatoires de Bruxelles et de Berlin, déterminée par des signaux galvaniques. 4to.—*From M. Ad. Quetelet.*

De la Statistique considérée sous le rapport du Physique, du Moral et de l'Intelligence de l'Homme. Par M. A. Quetelet. I^{er} Memoir. Brussels, 1860.—*From the Author.*

Table de Mortalité d'après le recensement de 1856. Par M. Ad. Quetelet.—*From the Same.*

Proceedings of the Royal Society of London. Vol. X., No. 39. 8vo.—*From the Society.*

Journal of the Royal Geographical Society. Vol. XXIX. 8vo.—*From the Society.*

Quarterly Journal of the Geological Society. No. 63.—*From the Society.*

The Canadian Journal. July 1860. 8vo.—*From the Editors.*

Journal of the Proceedings of the Linnean Society. Supplemental to Vol. IV. Zoology. 8vo.—*From the Society.*

Philosophical Transactions of the Royal Society of London, for the year 1859. Vol. CXLIX. Parts 1 and 2. 1860. 4to.—*From the Society.*

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Math.-Naturwiss. Classe. Bände XXXV., Nos. 10–12; XXXVI., 13–16; XXXVII., 17–21; XXXVIII., 23–28. Philos.-Histor. Classe. Bände XXX., Nos. 2 and 3; XXXI., 1–3; XXXII., 1, 2.—*From the Academy.*

Almanach der Kaiserlichen Akademie der Wissenschaften. 1859. 8vo.—*From the Academy.*

Proceedings of the Royal Physical Society of Edinburgh, 1854–58. 8vo.—*From the Society.*

Proceedings of the Royal Geographical Society of London. IV., No. 3. 8vo.—*From the Society.*

Monthly Notices of Royal Astronomical Society. Vol. XX., No. 8. —*From the Society.*

Memorials of the Families of De Boteville, Thynne, and Botfield. By Beriah Botfield. 1858. 4to.—*From Beriah Botfield, Esq.*

Du Raisin considéré comme médicament. Par J. Ch. Harpin. Paris, 1860. 8vo.—*From the Author.*

Journal of the Asiatic Society of Bengal. No. 95. 8vo.—*From the Society.*

On the Tertiary Deposits associated with Trap-Rock in the East Indies. By the Rev. Stephen Hislop. 8vo.—*From the Author.*

Observations des Phénomènes Périodiques. Par Ad. Quetelet. 4to.—*From the Author.*

Rymbybel van Jacob van Maerlant. Derde Deel. Brussel, 1859. 8vo.—*From the Royal Academy of Belgium.*

Annuaire de l'Académie Royal de Belgique. 1860. 8vo.—*From the same.*

Annuaire de l'Observatoire Royal de Bruxelles. Par A. Quetelet. 1859.—*From the Author.*

Patent Office Reports. 1857, 4 vols.; 1858, 4 vols.; 1859, 1 vol. 8vo.—*From the United States Government.*

Ohio Agricultural Report. 1857. Second Series. 8vo.—*From the same.*

Description of New Fossils from the Coal-Measures of Missouri and Kansas. By B. F. Shumard and G. C. Swallow.—*From the Authors.*

The Rocks of Kansas. By G. C. Swallow and F. Hawn. 8vo.—*From the Authors.*

Transactions of the Academy of St Louis. Vol. I., Part 3. 8vo.—*From the Academy.*

Geological Report of the South-west Branch of the Pacific Railroad, State of Missouri. By G. C. Swallow. St Louis, 1859. 8vo.—*From the Author.*

Popular Physical Astronomy. By D. Vaughan. Cincinnati, 1858. 8vo.—*From the Author.*

Grape Culture in Missouri. By G. C. Swallow. 1858.—*From the Author.*

Smithsonian Report. 1858. 8vo.—*From the Smithsonian Institution.*

Report of the Geological Survey of Missouri. By G. C. Swallow. 1855. 8vo.—*From the Author.*

Report of Geological Survey in Kentucky. By D. D. Owen. Vols. I. and II. 1857. 8vo.—*From the Author.*

The Passage to the North Pole. By Dr J. J. Hayes. 8vo.—*From W. Sharswood, Esq.*

Proceedings of the American Philosophical Society. Vol. VI., Parts 59–61.—*From the Society.*

Proceedings of the American Academy of Arts and Sciences. Pages 89 to 248.—*From the Academy.*

First Report of the Geological Reconnoissance of the Northern Counties of Arkansas. By D. D. Owen. 1858. 8vo.—*From the Author.*

Report of Geological Survey of Iowa. By James Hall and J. D. Whitney. 2 vols. 4to.—*From the Authors.*

Berichte über die Verhandlungen der K. Sach. Gesellschaft der Wissenschaften zu Leipzig. Philol.-Hist. Classe. 1859, Parts 1 and 2; 1860, Parts 1 and 2.—Math.-Phys. Classe. 1859, Parts 1–4.—*From the Royal Saxon Academy.*

Mémoires de l'Académie Impériale des Sciences de St Petersbourg. VII^e Série. Tome II., Nos. 1–3. 4to.—*From the Academy.*

Bulletin de l'Académie Impériale des Sciences de St Petersbourg. Tome I., Parts 1–36. 4to.—*From the Academy.*

Journal of the Asiatic Society of Bengal. New Series. No. 103.—*From the Society.*

Librorum in Bibliotheca Speculæ Pulcovensis anno 1858 exeunte contentorum Catalogus Systematicus. Edendum Curavit et Praefatus est Otto Struve. 1860. 8vo.—*From the Editor.*

Recueil de Mémoires des Astronomes de l'Observatoire Central de Russie. Vol. II. St Petersbourg. 1859. 4to.—*From the Imperial Academy.*

Reduction of Greenwich Lunar Observations, 1831–1851. 4to.—*From the Observatory.*

Mémorie della Reale Accademia della Scienze di Torino. Serie Seconda. Tomo XVIII. 4to.—*From the Academy.*

Denkschriften der Kaiserlichen Akadémie der Wissenschaften. Phil.-Hist. Classe. Band X. 1860. 4to. Math.-Naturwis. Classe. Band XVIII.—*From the Academy.*

Sitzungsberichte der K. Akademie der Wissenschaften. Phil.-Hist. Classe. Band XXXII., Parts 3 and 4; Band XXXIII., Parts 1 and 2; Band XXIV., Part 1.—Math.-Nat. Classe.

Band XXXIX., Parts 1–5; Band XL., Parts 7–12.—*From the Academy.*

Almanach der K. Akademie der Wissenschaften. Band X. 1860. —*From the Academy.*

Reports of the Geology, Botany, and Zoology of Northern California and Oregon made to the War Department. By John S. Newberry, M.D. Washington, 1857. 4to.—*From the Author.*

Memoirs of the American Academy of Arts and Sciences. New Series. Vol. VI., Part 2. 1859. 4to.—*From the Academy.*

Transactions of the American Philosophical Society. Vol. XII., Part 2. Philadelphia, 1859.—*From the Society.*

Report of the Superintendent of the Coast Survey for 1857. 4to. —*From Professor A. D. Bache.*

Journal of the Royal Asiatic Society. Vol. XVIII., Part 1. 8vo. —*From the Society.*

Proceedings of the Royal Medical and Chirurgical Society of London. Vol. III., No. 4. 8vo.—*From the Society.*

Journal of the Statistical Society of London. Vol. XXIII., Part 3. 8vo.—*From the Society.*

Proceedings of the Literary and Philosophical Society of Liverpool. 1860. 8vo.—*From the Society.*

The Quarterly Journal of the Chemical Society. No. 50. 8vo.—*From the Society.*

Proceedings of the Horticultural Society of London. No. 15. 8vo. —*From the Society.*

Quarterly Return of Births, Deaths, and Marriages. No. 22.—*From the Registrar-General.*

Scheikundige Verhandelingen en onderzoekingen. Uitgegeven door G. J. Mulder. Vol. III., Part 1.—*From the Dutch Government.*

Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland. October 1860.—*From the Society.*

Proceedings of the Royal Society of London. Vol. X., No. 40. 1860.—*From the Society.*

Of the Nature and Treatment of Diseases of the Heart. By James Wardrop, M.D. 8vo. 1859.—*From the Author.*

Madras Journal of Literature and Science. Vol. V., No. 10.—*From the Madras Literary Society.*

The Assurance Magazine. No. 41. 1860.—*From the Institute of Actuaries.*

Reply to Professor Tyndall's Remarks in his Work "On the Glaciers of the Alps" relating to Rendu's "Théorie des Glaciers." By James D. Forbes, D.C.L., &c. Edinburgh, 1860. 8vo.

Notices of Proceedings at the Meetings of the Members of the Royal Institution of Great Britain. Part 10. 1860.—*From the Royal Institution.*

Autobiography of a Seaman. By the Earl of Dundonald. Vol. II. 1860. 8vo.—*From the Author.*

Quarterly Journal of the Chemical Society. No. 51. 1860.—*From the Society.*

Canadian Journal. September 1860.—*From the Canadian Institute.*

Observations Météorologiques Faites a Nijné-Taguilsk. Paris, 1860.

Monthly Notices of Astronomical Society. Vol. XX., No. 9.—*From the Society.*

Proceedings of Horticultural Society of London. Nos. 17 and 18. 1860.—*From the Society.*

Papers read at the Royal Institute of British Architects. Session 1859-60.—*From the Institute.*

Geological Survey of Canada—Report of Progress for 1858. Montreal, 1859.—*From Sir W. E. Logan.*

Proceedings of the Zoological Society of London. 1860. Parts 1 and 2. 8vo.—*From the Society.*

Original Sanskrit Texts on the Origin and History of the People of India. By J. Muir, Esq., D.C.L. Part 2. 1860. 8vo.—*From the Author.*

Supplemental Chapter to "Acadian Geology." By J. W. Dawson, LL.D., F.G.S. 1860. 8vo.—*From the Author.*

On Distance-Measuring in Russia. By Professor C. P. Smyth. 1860. 8vo.—*From the Author.*

Journal of Proceedings of Linnean Society. Vol. V., No. 18.—*From the Society.*

Quarterly Return of Births, Deaths, and Marriages in Scotland. Quarter ending 30th September 1860.—*From the Registrar-General.*

Quarterly Journal of the Geological Society. Vol. XVI., Part 4. —*From the Society.*

Nouveaux Mémoires de la Société Impériale des Naturalistes de Moscow. Tomes XI., XII., XIII.—*From the Society.*

Bulletin de la Société Impériale des Naturalistes de Moscow. 1859, Parts 2, 3, and 4; 1860, Part 1.—*From the same.*

Philosophical Experiments and Observations of the late eminent Dr Robert Hooke. London, 1726.—*From Alex. Bryson, Esq.*

The Posthumous Works of Robert Hooke, M.D., F.R.S., containing his Cutlerian Lectures, and other Discourses. London, 1705. —*From Alex. Bryson, Esq.*

The Large Blasts at Holyhead. By G. Robertson, C.E.—*From the Author.*

A Monograph of the Carboniferous Brachiopoda of Scotland. By Thomas Davidson, Esq., F.R.S.—*From the Author.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. IV. 1860–61. No. 54.

Monday, 17th December 1860.

Professor KELLAND, Vice-President, in the Chair.

The following Communications were read:—

1. Contributions to the Natural History of Volcanic Phenomena and Products in Iceland. By W. Lauder Lindsay, M.D., F.L.S. Communicated by Professor Balfour.

These contributions are part of the results of the author's visit to Iceland in June 1860, and will be found embodied in his Paper "On the Eruption, in May 1860, of the Kötlugjá Volcano, Iceland," in the "Edinburgh New Philosophical Journal" for January 1861, page 6, with a map (Plate II.), "Illustrative of the Physical Geography of that part of the South of Iceland in which Kötlugjá is situated." The contributions in question may be classified under the following heads:—

(1.) *An Account of the Kötlugjá Volcano.*

- *a.* Its topography and geology.
- *b.* Peculiarities of its crater: the Icelandic *gjás* in relation thereto.
- *c.* Chronological record of its eruptions, which have been as follows:—

1st Eruption, A.D.	894	Interval since previous Eruption.
2d ...	934	... ... 40 years.
3d ...	1245	... ... 311 ”
4th ...	1262	... ... 17 ”
5th ...	1311	... ... 49 ”
6th ...	1416	... ... 105 ”
7th ...	1580	... ... 164 ”
8th ...	1612	... ... 32 ”
9th ...	1625	... ... 13 ”
10th ...	1660	... ... 35 ”
11th ...	1721	... ... 61 ”
12th ...	1727	... ... 6 ”
13th ...	1755	... ... 28 ”
14th ...	1823	... ... 68 ”
15th ...	1860	... ... 37 ”

d. Details of the Eruption of May 1860.

e. Main peculiarity of the eruptions of Kötlugjá—*water and ice-floods.*

f. Physical and geological character of the surrounding country, as determined by the phenomena and products of the eruptions of Kötlugjá.

(2.) *Notes on Icelandic Geology and Mineralogy.*

a. Palagonite and the palagonitic rocks; especially those of Seljadalr, Fossvogr, and the coast between Reykjavik and Havnafiord.

b. Basalts.

c. Obsidians.

d. Pumice-tuffs.

(3.) *Chemical Analyses:* of—

a. The waters of the Laugarnes hot-spring near Reykjavik.

b. Muds and other deposits from the same spring.

c. Muds and other deposits from the hot-springs of Krisuvik.

d. Sulphur-muds from Krisuvik.

e. Havnafiordite [of Forchhammer] from Havnafiord near Reykjavik.

f. Palagonite-tuffs from the coast between Reykjavik and Havnafiord.

g. Basalts and Trachytes from the Island of Videy near Reykjavik.

The large amount of *Silica* found in the water of the Laugarnes hot-springs is confirmatory of all former published analyses of the waters of the Geysers and other hot-springs in Iceland. The percentage of *Sulphur* in the Krisuvik sulphur-muds is *unusually high*, being from 96·39 to 98·20 of pure sulphur, while the crude Sicilian sulphurs generally contain not above 80 to 90 per cent.

(4.) *Hints to Naturalists anent Natural History Expeditions to Iceland.*

2. On the Pediculi infesting the Different Races of Man. By Andrew Murray.

The object of this paper was to determine whether the pediculi infesting the different races of man were of the same or of distinct species, and thereby to ascertain whether any inference could be drawn therefrom, bearing upon the disputed question of the unity of the human species.

The author had obtained specimens of pediculi taken from sixteen or eighteen different races of mankind, and had discovered certain minute differences which appeared to be constant in the different races. These differences, however, did not appear so different in particulars, or marked in degree, as to justify their being considered different species.

The following Donations were received:—

Transactions of the Historic Society of Lancashire and Cheshire. Vol. XII. 1860. 8vo.—*From the Society.*

Transactions of the Medico-Chirurgical Society. Vol. XLIII. 8vo. —*From the Society.*

Atti del R. Istituto Lombardo di Scienze, Lettere ed Arti. Fasc. 17–20. 4to.—*From the Institute.*

Quarterly Journal of Geological Society. Vol. XVI., Part 4.—*From the Society.*

Transactions of the Academy of St Louis. 1859. 8vo.—*From the Academy.*

Journal of the Proceedings of the Linnean Society. Vol. V., No. 18.—*From the Society.*

Comptes Rendus Hebdomadaires des Seánces de l'Academie des Sciences. Tom. LI., Nos. 22, 23.—*From the Academy.*

Memoranda on Vegetation. By John Hunter, F.R.S. London, 1860. 4to.—*From the Royal College of Surgeons, London.*

Catalogue of Plants and Invertebrata. 1860. 4to.—*From the same.*

Catalogue of Fossil Plants. 1855. 4to.—*From the same.*

Catalogue of Vertebrata in Spirit. 1859. 4to.—*From the same.*

Observations on Geology. By John Hunter, F.R.S. 1859. 4to. —*From the same.*

Catalogue of Fossil Reptilia and Pisces. 1854. 4to.—*From the same.*

Catalogue of the Histological Series. Vol. II. 1855. 4to.—*From the same.*

Journal of Geological Society of Dublin. Vol. VIII., Part 3.—*From the Society.*

Journal of Statistical Society of London. Vol. XXIII., Part 4. —*From the Society.*

Monthly Notices of Astronomical Society. Vol. XXI., No. 1.—*From the Society.*

A Treatise on Physiology and Anatomy in the Chinese Language. By Benjamin Hobson, M.B.—*From the Author.*

Treatise on Midwifery and Diseases of Infants in Chinese. By B. Hobson, M.B.—*From the same.*

Treatise on the Science and Art of Western Surgery in the Chinese Language. By B. Hobson, M.B.—*From the same.*

Treatises on Medicine and Natural Philosophy in the Chinese Language. By B. Hobson, M.B.—*From the same.*

A Medical Vocabulary in English and Chinese. By B. Hobson, M.B. 1858.—*From the same.*

Transactions of Botanical Society, Edinburgh, 1860.—*From the Society.*

Monday, 7th January 1861.

PROFESSOR CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. Note on Hydrated Sulphuric Acid. By Dr Lyon Playfair, C.B.

It is well known that hydrated sulphuric acid loses sulphuric anhydrid on heating, and that its specific gravity decreases in consequence. It is of some practical importance to know the exact circumstances under which this takes place, and the following experiments may prove useful in this respect. Sometimes, in distilling and subsequently evaporating sulphuric acid, I obtained a hydrate of sp. gr. 1·848, and at other times not exceeding 1·842. To explain these differences I took—

1. Monohydrated sulphuric acid, having the sp. gr. 1·848, and containing by alcametrical testing 81·62 per cent. of anhydrous acid, and buried the retort containing it in hot sand, and distilled. The distillate now contained only 80·12 anhydrous acid, and had a sp. gr. of 1·840 at 60° Fahr. It had lost in distillation about 1½ per cent of anhydrid.

2. The weak acid thus got by distillation was exposed to a temperature near to, but not exceeding, 554° Fahr., for forty minutes. On cooling, its alcametrical strength was 81·615 of anhydrid, and its specific gravity 1·84798.

3. A portion of the first acid, having the strength 81·62 of anhydrid, and the specific gravity 1·848, was boiled violently for two hours. On testing, it was now found to contain only 80·01 of anhydrid and to have a specific gravity of 1·838.

4. The weak acid got in the last experiment was kept for one hour at a temperature of 550° Fahr. The concentrated acid thus got gave 81·62 anhydrid and a specific gravity of 1·84792.

From these experiments, it follows, notwithstanding Marignac's researches, that there is a real monohydrated sulphuric acid obtainable by evaporation, and that its specific gravity is in reality as high as 1·848, which is the number formerly given in books; but that this hydrate is decomposed between the temperature of 550° Fahr. and the boiling point of oil of vitriol.

2. Note respecting Ampère's Experiment for showing the Repulsion of a Rectilinear Electrical Current on itself. By Principal Forbes, LL.D., &c.

The experiment referred to was performed in 1823 by Ampère in the presence of Mr A. De la Rive. It is intended to show that if one portion of a rectilinear conductor is made moveable, it will be repelled from the portions which form its continuation. The arrangement employed was a copper wire-float in a double trough of mercury, which cannot easily be explained without a figure.

This experiment, though quoted by most writers on electricity, is understood to be one not easily repeated. Indeed, the author has not found an indication of its ever having been repeated with success. The author conceiving that perhaps this repulsion described by Ampère might assist in explaining the vibrations of rocking bodies through which an electrical current passes (as described in a communication by him to this Society in January 1859), devised another, and, as he conceives, a more delicate method of testing the supposed repulsion of a rectilinear current on itself. This he accomplished by connecting the two poles of a battery by means of a piece of copper-wire shaped like a horse-shoe, and laid upon one extremity of a slender wooden lever suspended by a fine platinum wire, after the manner of a torsion balance. Yet, on the establishment of the circuit through the bent wire, so far was there from being any repulsive force tending to separate the torsion rod from the battery poles, that the connecting horse-shoe was sensibly and even powerfully attracted to the poles, both while the current lasted, and for some time after.

This experiment seems to throw a doubt upon Ampère's conclusion. The author believes that his mode of experimenting is not only much more delicate than that of Ampère, but also that it avoids sources of ambiguity present in the other.

3. Fragmentary Notes on the Generative Organs of some Cartilaginous Fishes. By John Davy, M.D., F.R.S. Lond. and Edin., &c.

These notes, it is stated by the author, were made at different times and places, as opportunity favoured, and are offered as a contribution to a difficult branch of Ichthyology.

The generative organs of nine different species are described, with more or less minuteness of detail. The species are *Squalus squatina*, *S. galeus*, *S. acanthias*, *S. carcharias*, *S. centrina*, *S. canicula*, *Scyllium melanostomum*, *Raia aquila*, and *R. oxyrhynchus*.

From the observations made, these species would appear to differ in some essential points as regards the reproductive process; some, as the *S. squatina*, being viviparous,—their ova developed or hatched in the uterine cavity; others, as *S. acanthias* and *S. carcarias*, being oviporous, their ova included in a shell with a white, yet developed in the same cavity, the presence of a shell constituting the difference comparing them with the preceding; others, as *R. aquila*, and *S. canicula*, being oviparous, their eggs experiencing no embryonic development in the oviducts, and hatched after exclusion in the sea.

Respecting the anal appendages, the characteristic of the male cartilaginous fish, the opinion the author is most inclined to adopt is, that they are not claspers, but rather organs of intromission; preferring this latter—the old view of their use, as noticed by Aristotle—to the former, which is the more recently entertained one, from considering their structure and certain facts which have come to his knowledge.

Concerning the branchial filaments, which have commonly been held to be mainly subservient to the supplying with air the blood of the embryo, he thinks they may have another use also; that of aiding the growth of the parts to which they belong. Their early absorption, and being sometimes found in other regions of the embryo than the branchia, are brought forward as circumstances favourable to this idea.

The following Gentlemen were admitted Ordinary Fellows:—

WILLIAM A. F. BROWNE, F.R.C.S.E.
Rev. THOMAS BROWN.
ROBERT EDMUND SCORESBY-JACKSON, M.D., F.R.C.S.E.
JAMES M'BAIN, M.D., R.N.
Professor P. GUTHRIE TAIT.

The following Donations to the Library were received:—

Transactions of Royal Scottish Society of Arts, Vol. V., Part 4. 8vo.—*From the Society.*

Proceedings of Royal Society of London, Vol. X., No. 41.—*From the Society.*

Proceedings of the Horticultural Society of London, Vol. I. Nos. 18, 19. 8vo.—*From the Society.*

Jahresbericht der Chemie, von H. Kopp u. H. Will. Giessen, 1860. 8vo.—*From the Authors.*

Proceedings of the Academy of Natural Sciences of Philadelphia, pp. 81–284. 8vo.—*From the Academy.*

Etudes et Expériences Synthétiques sur le Metamorphisme, par M. Daubrée. Paris. 1860. 4to.—*From the Author.*

Observations Meteorologiques faites à Nijné Taguilsk. Année 1857. 8vo.

Sitzungsberichte der Königl. Bayer. Akademie de Wissenschaften zu Munich. 1860. Part 2.—*From the Academy.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt. 1860. No. 1. 8vo.—*From the Society.*

Bulletin de la Société de Géographie. Quatrième Série. Tome XIX. 1860.—*From the Society.*

Memorie dell'Accademia delle Scienze dell'Istitnto di Bologna. Vols. VIII., IX., X., Part 1. 4to.—*From the Institute.*

Rendiconto delle sessioni dell'Accademia delle Scienze dell'Istituto di Bologna. 1858–59. 8vo.—*From the Society.*

Mémoires de l'Académie des Sciences de l'Institut Imperial de France. Tome XXX. 4to.—*From the Institute.*

The Canadian Journal, November 1860. 8vo.—*From the Canadian Institute.*

Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences. Tome LI., Nos. 24–26.

Norsk Forfatter-Lexikon 1814–56 af Jens E. Kraft. Parts 1–5. Christiania, 1857. 8vo.—*From the Royal University of Christiania.*

Index Scholarum in Universitate Fredericiana. Christiania, 1860. 4to.—*From the same.*

De vi logicæ rationis in describenda philosophiæ historia ad Eduardum Zellerum epistola quam scripsit M. J. Monrad.—*From the same.*

Forhandlinger i Videnskabs-Selskabet i Christiania, aar 1859. 8vo. —*From the same.*

Radcliffe Catalogue of Stars for 1845. Oxford, 1860. 8vo.—*From the Radcliffe Trustees.*

Catalogus van de Boekerij der Kon. Akad. van Wetenschappen. Amsterdam, 1860. 8vo.—*From the same.*

Verslagen en Mededeelingen der Kon. Akad. van Wetenschappen. Amsterdam, 1840. 8vo.—*From the same.*

Jaarboek van de Kon. Akad. van Wetenschappen. Voor, 1859. 8vo.—*From the same.*

Verslag over den Paalworm. 1860. 8vo.—*From the same.*

Transactions of the Bombay Geographical Society, Vol. XV. 8vo. —*From the Society.*

The Assurance Magazine and Journal of the Institute of Actuaries. January 1861.—*From the Institute.*

Journal of Agriculture and Transactions of the Highland and Agricultural Society of Scotland, No. 71, New Series.—*From the Society.*

Monday, 21*st January* 1861.

The Very Rev. DEAN RAMSAY, V.P., in the Chair.

The following Communications were read:—

1. On a Method of taking Vapour Densities at Low Temperatures. By Dr Lyon Playfair, C.B., F.R.S., and J. A. Wanklyn, F.R.S.E.

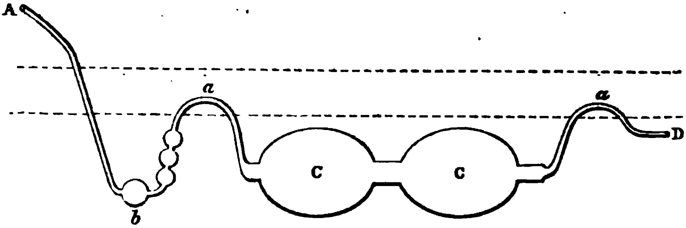
The authors refer to Regnault's experiments, which have shown that aqueous vapour in the atmosphere has the same vapour density at ordinary temperatures as aqueous vapour above 100° C.; and they bring forward fresh experiments upon alcohol and ether to show that when mixed with hydrogen these vapors preserve their normal density at 20° or 30° C. below the boiling points of the liquids, and infer generally that vapours, when partially saturating a permanent gas, retain their normal densities at low temperatures.

From their researches the authors deduce the consequence—remarkable, but quite in harmony with theory, that permanent gases have the property of rendering vapour truly gaseous. Stated in more precise terms, the proposition maintained by the authors is, "The presence of a permanent gas affects a vapour, so that its expansion-coefficient at temperatures near its point of liquefaction tends to approximate to its expansion-coefficient at the highest temperatures."

The authors anticipate that admixture with a permanent gas may serve as a kind of re-agent to distinguish between cases of unusually high expansion-coefficient in a vapour, and cases where chemical alteration takes place. It will also be possible, by the employment of a permanent gas, to obtain vapour-densities of compounds which will not bear boiling without undergoing decomposition.

In experimenting upon substances which may be heated above the boiling point, the authors employ Gay Lussac's process for taking the specific gravity of vapours. A slight modification is, however, necessary. Previous to the introduction of the bulb containing the weighed substance, dry hydrogen is introduced into the graduated tube and measured with all the precautions belonging to a gas analysis. It will be obvious that in the subsequent calculation the volume of hydrogen corrected at standard temperature and pressure must be subtracted from the volume of mixed gas and vapour, also corrected at standard temperature and pressure.

When the substance will not bear heating to its boiling point, the authors employ a process resembling that of Dumas in principle, but differing very widely from it in detail. Dumas' flask with drawn-out neck is replaced by two bulbs, together of about 300 cub. cent. capacity, joined by a neck, and terminating on either side in a narrow tube. One of the narrow tubes has some very small dilatations blown upon it (*b*), the other is merely bent (D). (See the drawing.) The apparatus, whose weight should not exceed 70 grm., is weighed in dry air, then placed in a bath, being secured by a retort-holder grasping the neck joining the large bulbs C and C. The end A, projecting over the one side of the bath, is made to communicate with a hydrogen apparatus; the end D passes through a hole in the opposite side of the bath, which is plugged up watertight by means of putty. Dry hydrogen is transmitted through the whole arrangement, and escapes at D through a long narrow tube joined to it by a caoutchouc connecter.



The bath is next filled with warm water until the bends *a* and *a* are covered. The connection with the hydrogen apparatus is then for a moment interrupted, to allow of the introduction of a small quantity of the substance at A. The substance, which should not more than half-fill the small bulb *b*, is partially vaporised in the stream of hydrogen, and in that state passes into the part CC. All the while, the temperature of the bath is kept uniform throughout by constant stirring, and made to rise very slowly. When within a few degrees of the temperature at which the determination is to be made, the current of hydrogen is almost stopped, so that the bulbs C and C may contain less vapour than will fully saturate the gas at the temperature of sealing. The water of the bath is then made to subside, by opening a large tap placed near the bottom. The bends *a* and *a* are thus exposed, the bulbs CC remaining covered. Immediately the current of hydrogen having been stopped, the flame is applied at *aa*, so as to seal the apparatus hermetically. The temperature of the bath, as well as the height of the barometer, must now be observed. After being cleaned, the apparatus (which now consists of three portions, viz., the portion CC hermetically sealed and the two ends *b* and D) must be weighed.

The capacity of the apparatus is found by filling it completely with water and weighing; but previously to this operation the volume of hydrogen enclosed at the time of sealing must be found. On breaking one extremity under water, the water will rise in the bulbs, and, after a while, will have absorbed all of the vapour, but will leave the hydrogen. The bulbs must then be lifted out of the water, without altering their temperature, and, with the water that has entered, weighed. The difference between the latter weighing and the weight of the bulbs quite full of water gives the weight in grammes, which expresses in cubic centimeters the volume of hydrogen enclosed; the pressure is the height of the barometer minus the column of water which had entered the bulbs; the temperature is that of the water.

An example of a determination of the vapour density of alcohol at 30° C. below its boiling point is subjoined :—

Height of the barometer (at 0° C.),	763·09 m.m
Temperature of the balance case,	7·5° C.
Weight of apparatus in dry air,	69·959 grm.
Temperature at time of sealing,	48° C.
Weight of apparatus + hydrogen + vapour,	69·5275 grm.
Weight of apparatus + water (at 5.2° C.)	191·76 grm.
Weight of apparatus filled with water,	545·36 grm.
Height of water column,	122 m.m.

From which is deduced :—

	Volumes corrected at 0° C. and 760 m.m. pressure. Cubic centimeters.		Grm.
Hydrogen + vapour,	406·43	weighing	0.1695
Hydrogen,	341·27	„	0·0306
	65·16		0·1389

Therefore, 65·16 cub. c. of alcohol vapour weigh ·1389 grm.
but 65·16 cub. c. of air weigh ·0843 grm.

$$\text{Vapour density of alcohol} = \frac{\cdot 1389}{\cdot 0843} = 1\cdot 648$$

The authors have extended their experiments to acetic acid and other substances. At low temperatures the vapour-density of acetic acid approximates to 4·00, no matter how much hydrogen be employed. At higher temperatures, an approximation to 2·00 is obtained, but without heating so high as Cahours found necessary.

The authors are continuing these researches.

2. Memoir of Sir Thomas Makdougall Brisbane. By Alexander Bryson.

The following Donations were laid on the Table :—

Journal of Proceedings of the Linnean Society—Supplement to Vol. V.—Botany. 8vo.—*From the Society.*

Bulletin de la Société des Sciences Naturelles de Neuchatel. Tome, V., Pt. 2. 1860. 8vo.—*From the Society.*

Quarterly Report of the Meteorological Society of Scotland, for the quarter ending 30th September 1860.—*From the Society.*

Monthly Notices of the Royal Astronomical Society. Vol. XXI. No. 2.—*From the Society.*

Proceedings of the Royal Society of London, Vol. XI., No. 42. 8vo.—*From the Society.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome LII., No. 1.—*From the Academy.*

Monthly Return of Births, Deaths, and Marriages in Scotland. December 1860.—*From the Registrar-General.*

Catalogue of the Edinburgh Medical Society's Library. 2 vols., 1837 and 1845. 8vo.—*From the Society.*

Monday, 4th February 1861.

Principal FORBES, V.P., in the Chair.

The following communications were read:—

1. Notes on the Snow Crystals observed during the late Frost. By Professor Allman.

On the 26th of December last, about half-past 11 A.M., a light snow shower fell in Edinburgh, and lasted about half an hour. The air was at the time still, and the sky overcast with a thin haze, while the thermometer stood at many degrees below the freezing point. The appearance of the snow was very remarkable. It fell in loose open flakes, and lay upon the surrounding objects in little masses like tufts of exquisitely white, soft and light down.

Remembering the descriptions of the crystals of snow in high arctic regions, and during intense frost even in our own latitudes, as given by Scoresby, Glaisher and others, I was desirous of determining how far the structure of the snow now falling corresponded with the accounts of these observers. I accordingly, with the view of rendering their composition more apparent by contrast with a dark surface, collected a few of the falling flakes upon a sheet of blackened pasteboard, when, even to the unassisted eye, a structure of marvellous beauty was at once revealed. The white down-like snow-flake was now seen to be an aggregate of symmetrical and transparent ice stars, many of them more than a quarter of an inch in diameter. When examined under the compound microscope with the aid of a two-inch object-glass, their beauty became still further enhanced, and it was then seen that every star was itself composed of a multitude of transparent crystals, in some cases tabular, in some acicular, and all grouped in obedience to a definite law, so as in their wonderful assemblages to give rise to shapes of exquisite symmetry,—shapes, too, of almost infinite variety; the kaleidoscope, in its magical transformations, is not more rich in forms,—yet all pervaded by an unbroken unity, for their type had been already fixed; and even in their most sportive mood, they could be seen to be under the control of a definite number and a definite quantity—the number 6 and the angle of 60° determining their form and limiting their variations.

Among the various figures which I observed on the occasion referred to, we may perhaps select, as the archetypal combination, a 6-rayed star (fig. 1), having for its centre or nucleus a tabular crystal in the form of a regular hexagon, each of whose angles supports one of the six rays of the star. Each of these rays would seem to be a very much elongated hexagonal prism, and every one of them gives off from each side, and in the common plane of the figure, secondary arms, which spring from it with a pinnate arrangement, and at an angle of 60°. These secondary arms in the figure under consideration are also elongated hexagonal prisms; in the greater number of instances, however (figs. 2–5), the secondary arms are wedge-shaped, and probably the result of more complex conditions than those under which the type form is produced. The axis of symmetry of each of these wedge-shaped arms is inclined to the ray at an angle of 60°, but I cannot say at what angle the sides of the arms are inclined to one another. The central hexagon in the figure, from which the sketch was taken, was marked with elegant concentric striæ.

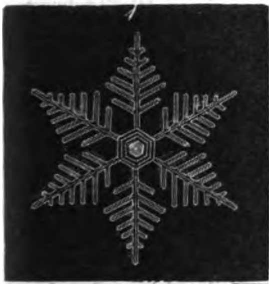
It is here worth noting, that the figure I have assumed as the type consists exclusively (if we except the termination of the arms) of a combination of the two limiting forms of the Rhombohedron m R; namely, that in which m becomes practically 0, and that in which it becomes infinite, producing in the former case the tabular crystal 0R, which constitutes the centre of the figure, and in the latter case the prismatic crystals ∞ R, which constitute the rays and their branches.

Assuming then the form now described as the type, there would seem to be but little difficulty in deducing from it most of the peculiarities presented by the other figures which I have had an opportunity of observing. In fig. 2, the central hexagon has disappeared, and the rays meet at a point in the centre of the star.

In fig. 3, a tabular hexagonal crystal is developed diagonally in the course of each ray at a uniform distance from the centre, and in the common plane of the star.

Fig. 4 is easily derived from fig. 3; for in order to produce it, we have only to suppose all the six hexagons to be simultaneously prolonged in the direction of the ray, until they meet in the centre of the figure, when, in consequence of mutual and symmetrical interference, they will terminate in an angle of 60°, or of half the proper angle of the hexagon, thus forming *maccles* whose plane of union is inclined to the principal axis of the ray at an angle of 30°.

In fig. 5 we have a central hexagon, carrying symmetrically on each of its angles a wedge-shaped five-sided table, which thus takes the place of the acicular ray in fig. 1. Three of the sides of this table appear to be those of the regular hexagon, while the remaining two sides would, if continued, meet at an angle which I have not been able to measure, somewhere within the central hexagon. From each of the free angles of the wedge-shaped ray, a little hexagonal prism is developed.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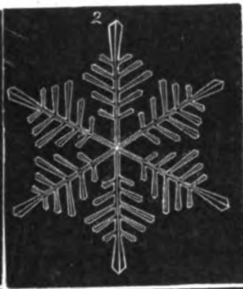
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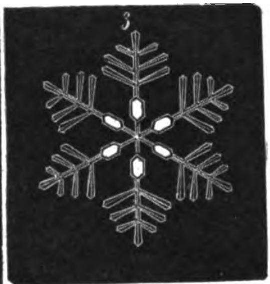
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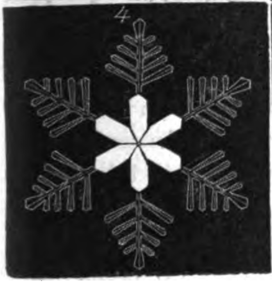
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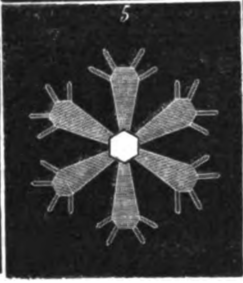
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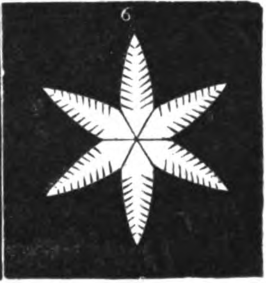
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The simply pinnate rays of fig. 2 occasionally become doubly pinnate. I have found even trebly pinnate varieties.

I also noticed a form (fig. 6) which is not exactly traceable to the *type*, and which I am inclined to view rather as an abnormal condition induced upon one of the other forms by the coalescence, or imperfect development, of the secondary arms. It consisted of a six-rayed star, in which the rays, instead of being prismatic or wedge-shaped, were lanceolate, the curved boundaries thus bringing this modification almost entirely into the type of organic form. The edges of the rays were marked with pinnate serrations or striæ.

In this last form we are strongly reminded of the beautiful stellate figures, like six-petalled flowers, which have been recently described by Professor Tyndal as being developed within a block of ice, when the rays of the sun are concentrated on a point in the interior of it by a burning lens.

Besides the forms now described, the snow which fell on the 26th contained many others, any one of which would well repay the trouble of drawing, though no figure can give an adequate idea of the elegance of the actual object, in which the most beautifully symmetrical flowers, and elaborately divided fern leaves, are repeated with that marvellous fidelity with which inorganic nature occasionally imitates the forms of organisation when the formative forces are directed by an undeviating symmetry.

But the ordinary snow of our latitude is not thus constituted. We may seek in vain in the snow as it usually falls with us for the beautiful stellate crystalline groups now described. Why is this? There are doubtless needed, for the perfect development of the ice crystals in the freezing cloud which is about to descend in the form of snow, several conditions, as yet but partially understood. Of these, it is posssible that a temperature considerably below the freezing point may be one, and a stillness in the higher regions of the atmosphere, where the snow is formed, another. It is exceedingly probable, as has been ingeniously suggested by Fr. Vogel,* in explanation of the phenomena of hail, that if the atmosphere be perfectly still, the particles of visible vapour constituting the cloud may be cooled far below the freezing point without freezing; and if in this state a crystal of ice be precipitated into the cloud from some higher elevation, or the stratum of cold vapour be agitated by sudden exposure to some atmospheric current, the balance between the forces of cohesion and adhesion will be destroyed, and the whole cloud will instantly shoot into beautiful ice-crystals, and will fall towards the earth as stellate snow; for the peculiar constitution of the visible vapour is such, that unimpeded action will be permitted to the forces of crystallisation, and no mechanical obstacle will be offered to the perfectly symmetrical development of the crystalline groups.

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* See Müller's Kosmische Physik, p. 421.

If the temperature of the inferior strata of the atmosphere be sufficiently low, the snow-crystals will reach the earth unaltered; but if, in their descent, they happen to pass through strata whose temperature is above the freezing point, they will—if they be not actually converted into rain—lose the sharpness and beauty of their outline, while partial thawing, followed, at the surfaces of contact, by the singular phenomenon of regelation, which, as has been shown by Faraday, may take place in an atmosphere considerably above the freezing point, will probably contribute to their irregular conglomeration into an ordinary snow-flake, contrasting as this does so strongly with the light, open, down-like flake produced under circumstances favourable to the perfect development and persistence of the crystals.

On the 27th, the snow which had fallen during the preceding day was still lying on the ground, and, with the view of continuing my observations, I again placed some of it under the microscope. I now, however, found that the crystals had lost all their beauty, and no longer presented the sharpness of outline and symmetry of form which had so forcibly struck me the day before. And yet, during the interval, the thermometer had never risen to the freezing point, nor had the snow been exposed to the direct action of the sun. The change of form thus undergone by the crystals appears to me to admit of but one explanation, and is evidently due to the partial dissipation of the crystal by evaporation, thus affording an interesting example of the evaporability of ice at temperatures considerably below the freezing point.

While on this subject, I may as well mention another fact illustrative of the same phenomenon.

It will be remembered that on more than one occasion during the severe frost a dense fog settled over the city, and was afterwards condensed and frozen on the surrounding objects, covering everything on which it lay, but especially the naked branches of the trees, with the most exquisite frostwork. This beautiful phenomenon, however, was but of short duration; for in less than twenty-four hours, though the temperature continued all the while below the freezing point, and the air free from wind, which might have shaken the frozen particles from the trees, yet not a trace of the frostwork remained.

To form, then, a true conception of the constitution of a snow-flake produced under the conditions which prevailed during the late intense frost, we have only to imagine thousands of stellate groups, such as those just described, entangled together by their complex arms into little loose flocculent masses. The peculiar light down-like character of the snow which fell on the 26th of December is thus easily understood.

On the 7th of January, between 4 and 5 P.M., the sky overcast, and the thermometer standing considerably below the freezing point, Edinburgh was visited by another snow shower. On this occasion the shower was of a very peculiar kind, for the stellate groups of crystals, instead of being aggregated into flakes, as in the shower of the 26th December, were for the most part isolated and distinct, so that the whole atmosphere was filled with separate ice-stars in inconceivable multitudes, whirling through the air, and drifting past one another in mazy paths which no eye could follow, so endless were their intersections, and inextricable their labyrinths; the wonderful ice-drift heaping itself up like white sand on the surrounding objects, but when projected against dark surfaces, revealing itself in all the unrivalled symmetry and beauty of its starry atoms. The chief difference between the present snow shower and that which fell on the 26th December, consisted in the segregation of its crystalline particles. There was a brisk breeze stirring at the time, in the lower regions of the atmosphere, and this was doubtless the invisible analyst that broke up the snow-flakes into their component elements, and flung them in stars and flowers to the earth.

The following Note from Mr Stephens to Dr Balfour was also read:—

REDBRAE COTTAGE, 14*th January* 1861.

MY DEAR SIR,—In December 1859, I was visiting Sir Robert Peel at Drayton Manor, in Staffordshire; and while there, a very heavy hoar-frost occurred for nearly two days,—every tree and shrub and the grass was fringed with most beautiful silver filagree. When walking along the shrubbery in the forenoon, I was led, from the remarkable exuberance of the hoar-frost, to examine it more minutely than by a casual glance; and to my surprise and delight, I perceived that the crystals presented quite a different arrangement on different bushes of evergreens. This there was no doubt of, as I could easily discern the difference in the arrangement of the crystals by the help of a large magnifying glass which I always carry with me when I go from home. I regret I did not take a sketch of the different arrangement of the crystals ; but not being prepared for such a proceeding, and being no hand at sketching, I contented myself with looking from one bush to another. And while thus engaged for some time, I thought I made an interesting discovery—namely, that while different bushes presented a different form of crystallisation, the same sort of bush presented the same form of crystals. This discovery interested me very much—for discovery I deemed it, not having observed any mention of such a thing in any book on meteorology I have seen. Thus, Portugal laurels, laurel bays, laurustinas, different sorts of Arbor-vitæ, the yew, some of the new pines, presented different forms of crystals, but the same kind of plant had the same form of crystal. This I made sure of by repeated observation in different parts of the shrubbery; and more than that, the size of the crystals was about in proportion to the size of the leaves of the evergreens. Thus, the crystals in the Portugal laurel, laurel bays, and larger leaved kinds of evergreens, were larger than on the leaves of the laurustina, and these latter larger than in those of the yew and Arbor-vitæ. The crystals, moreover, were not spread over the surface of the leaves, but only along their margins; and the leaves above, that were exposed fully to the air, had the crystals—those within the bush, or under shelter of the leaves above them, were free of all hoar-frost. I may mention that the sun was obscured the first day by a frost-fog; the second day was clear, but the crystals retained their form where the sun did not strike; and on the following morning, the whole fairy scene had disappeared. Tall grasses and sedges by the side of a lake presented different crystals, but the same kind of plant similar forms. The naked branches of trees presented similar results. . . . .

I am, &c.,

HENRY STEPHENS.

2. The Bifilar Magnetometer: its Errors and Corrections. By John Allan Broun, F.R.S., Director of the Trevandrum Observatory. Communicated by Professor Tait.

The bifilar magnetometer has been employed in all the magnetical observations, with an exception or two; its theory has been stated generally, but no careful examination of the errors of the instrument, as deduced from experience, has been published. The author has attempted to supply this deficiency.

In the theory of the instrument, the proper elasticity of the wires has been neglected, as of little importance. The author shows that the wires receive a twist in the adjustment, which puts the upper suspension-points into a different plane from the lower ones; that the force so produced enters into the equation of equilibrium in a marked manner. The theoretical conclusion is verified by experiments on the torsion force of the wires. But as a proper twist generally exists, the angle of torsion, as well as the time of vibration, are unfitted for an accurate determination of the coefficient which relates the same divisions to the unit. Different methods of determining the unit coefficient are noted, and the results of experiments are given.

The greatest source of error in connection with the observations is that due to varying temperature. It has been usual to suppose that the temperature affected only the magnetic moment of the magnet, and the length of the wires and the interval separating them. It is shown that it affects also the coefficient of elasticity of the wires. Experiments made hourly during many days, with an unmagnetic weight suspended by two wires, are cited, to show that the varying temperature produces effects on the position which might be expected from theoretical considerations.

A method proposed by the author in 1842, and described in the "Edinburgh Transactions" in 1845 (vol. xvi. p. 74), by which a temperature coefficient is found, including all the effects, is then noticed, and the results obtained from discussions of all the observations of the bifilars in the colonial observatories (including the observations of nearly twenty-eight years), are given. From these it appears that the coefficients usually employed are on the average nearly one-half too great, and in some instances they are the double of the true coefficients.

The author concludes by a notice of the accidental errors to which the instrument is liable.

3. On the Horizontal Force of the Earth's Magnetism. By John Allan Broun, F.R.S., Director of the Observatory of the Rajah of Travancore. Communicated by Professor Tait.

The conclusions of this paper are derived from observations made at Makerstoun in Scotland; Toronto, Canada; Trevandrum, Travancore, and Singapore, East Indies; St Helena, the Cape of Good Hope, Hobarton, Van Dieman's Island, &c. The author has corrected and discussed all the observations published made in the colonial observatories.

The observations have been found affected by different errors, and frequently the series have been broken. An attempt has been made to correct these series; and, in general, to render the series as near the truth as possible. The grounds for all these corrections are given in an appendix.*

The results obtained may be summed up as follows:—

Secular Variation and Mean Yearly Force.

1*st*, The secular change of the horizontal intensity followed the same law, and had the same value very nearly, at Makerstoun in Scotland, and at Hobarton, Van Dieman's Island, the units being the absolute force at the respective places.

2*d*, The law of change is, however, not linear, but had a maximum at both places, at the mean epoch, January 1844, and a minimum about July 1847.

3*d*, At other stations the secular change has not always the same value as at Makerstoun and Hobarton, nor has it always the same duration.

4*th*, The yearly mean force was sometimes an increase at *all* the stations, and it is concluded that the yearly mean intensity of the magnetism of the whole earth is not a constant quantity.

5*th*, The secular change is probably a result of two causes—one dependent on the position of the earth's magnetic poles, the other dependent on their varying intensity.

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* Some observations examined were found valueless, on account of errors which could not be corrected; and in one case the requisite data for accurate correction were wanting.

Annual Period.

6*th*, The annual period confirmed by each year's observation, and by groups of years at Makerstoun and Hobarton, at Trevandrum, Singapore, Toronto, &c., is, that the horizontal intensity of the earth's magnetism is a maximum near the solstice and a minimum near the equinoxes. The equations for Makerstoun and Hobarton, according to the function of sines, for the group of years July 1844 to June 1848, are as follows:—

Makerstoun, $y = 5{\cdot}20 + 1{\cdot}66 \text{ sin. } (\theta + 161^\circ\ 47') + 2{\cdot}98 \text{ sin. } (2\theta + 129^\circ\ 34') + 0{\cdot}80 \text{ sin. } (3\theta + 31^\circ\ 42')$

Hobarton, $y = 4{\cdot}90 + 1{\cdot}64 \text{ sin. } (\theta + 217^\circ\ 38') + 2{\cdot}54 \text{ sin. } (2\theta + 129^\circ\ 11') + 0{\cdot}45 \text{ sin. } (3\theta + 172^\circ\ 46')$

Where $\theta = 0$ July 16, and the unit is one 100,000th of the horizontal intensity at each place.

7*th*, The epochs for the total curve deduced from these equations are—

	Makerstoun.	Hobarton.
Principal Minimum . .	October 1.	September 16.
„ Maximum, . .	December 22.	January 1.
„ Minimum, . .	March 6·5.	April 4.
„ Maximum, . .	June 30·5.	June 17.

8*th*, The law is confirmed by the observations at Munich in 1843–5, made with a unifilar instrument where deflecting magnets are used, and where the probable error due to the varying torsion of the silk suspension-fibres, and the small directive force of the suspended magnet, renders such a confirmation the more remarkable.

9*th*, The law is also confirmed by a discussion of observations of *absolute* horizontal intensity made at Toronto, the Cape of Good Hope, and Hobarton. The results of these observations are shown to be faulty, from the inaccuracy of the temperature coefficients employed; but the error due to this cause will appear in the term A_1 sin $(\theta + C_1)$ of the equation of sines, while the term A_2 sin $(2\ \theta + C_2)$ on which the double maximum and minimum depend, may be expected to be free from the error, and to show the law. The observations are discussed, and the term obtained in each case differs little from the mean of the terms from the Makerstoun and Hobarton bifilars, or—

$$2{\cdot}76 \sin (2\,\theta + 129^\circ.)$$

10*th*, The usual method of taking monthly means gives only twelve points for the whole year, each point corresponding to the middle of a calendar month, the means being supposed to vary regularly from point to point. The author has combined two years' observations for four places (Makerstoun, Trevandrum, Singapore, and Hobarton), so as to have four weekly means corresponding to each day in the year (Sundays excepted), and the most minute variations of these four weekly means for any one place are followed by those for the others. This fact is, however, only a corrollary to the following:—

Daily Mean Variations.

11*th*, The daily mean horizontal force at all places on the surface of the globe increases simultaneously or diminishes simultaneously. The amount of increase or of diminution has generally the same value (the horizontal force at each place being the unit), so that the increase or diminution is in proportion to the absolute value of the horizontal intensity at the respective places. The variations from this result can be traced to disturbances which seem sometimes to have a greater effect on the daily mean near the poles than near the equator.

12*th*, In order to follow the variations of the daily mean in shorter intervals than one day, the author has combined the observations so that daily means are obtained corresponding for their middle points to each hour of the twenty-four, instead of to one hour only. This has been done for a period of six weeks only, including one of the 26-27 day periods (see 13*th*) for the four places above mentioned (10*th*), and for Toronto and the Cape of Good Hope. The results are that the turning-points frequently agree to the same hour, though they also frequently differ to several hours; the greatest variation being connected with large disturbances in high latitudes. Marked turning-points, maxima or minima at one place, are sometimes shown only as minor turning-points; at others, and in the cases of some large disturbances, while the turning-point (say the commencing diminution of force) occurs at the same instant on all meridians, the rate or velocity of change is not the same in all—the rate probably depending on the hour of the day at which the disturbance has its maximum value at different places, the local law of disturbance being superposed on the general law of mean daily variation.

13*th*, It follows from these results, that the daily mean absolute intensity of the whole earth is not a constant quantity, but that it increases as a whole, and diminishes as a whole, from day to day.

14*th*, In the examination of the usual daily means for the years 1842–48 (though the years 1844–45 only are considered in this paper), it appears that there is a period of about 26·2 days on the average, which is felt equally (within the limits of errors of coefficients) and simultaneously at all the stations. This period was remarked by the author in his discussion of the Makerstoun Observations for 1844–45; it was attributed at that time to the action of the moon, and the law obtained connected with its synodical revolution. The author gives grounds to show that it is probably due to the sun. The identity of the movement at all stations at the same time, whatever may be the position of the moon, would of itself disprove the connection of our satellite as the cause of this period. An examination of a larger series of observations than that considered in this paper will show that the minimum frequently takes place at full moon, as well as at new moon.

15*th*, The author has avoided theoretical speculations in his paper, but he believes that the moon acts as a secondary cause, the large disturbances occurring most frequently near full moon. This fact, he thinks, hypothetically, may be connected with an electric fluid emanating from the sun, acted on by the planets, and drawn towards the earth most powerfully when the moon is in opposition. This action does not prevent, though it occasionally masks, the period due to the rotation of the sun itself, and the unequal electrical tension of its different sides—this difference being also probably connected with the solar spots. It is obvious that should the moon and planets act in the way supposed, the period due to the sun's rotation will appear to vary within certain limits, independently of the supposition that the sun's side of greatest tension is variable. Such an hypothesis would connect the secular variations with the electrical tension of the sun, and the periods of the planets. The author proposes to consider this question more at large hereafter, in a discussion of all the observations from 1840 up to the present time. He concludes by noticing the appearance of a period of about sixty to seventy hours in the daily mean variation.

4. Notice of an Instrument intended for the Measurement of Small Variations of Gravity. By John Allan Broun. Communicated by Professor Tait.

If we suspend a weight by two wires, and turn the weight suspended from its position of repose through an angle v by means of any force, the wires will no longer be vertical, and the weight will be lifted from its lowest position by a gravity equal to $l \sin i \tan i$ where l is the length of a wire and i is the small angle which it makes with the vertical. If we represent the force which keeps the weight W from its position of rest by f, and the intervals of the wires above and below by a and b, it is known, as in the case of the bifilar magnetometer, that the equation of equilibrium is—

$$f = \mathrm{W} \frac{ab}{l \cos i} \sin v.$$

If we suppose the force f to be constant, and that only W and v vary by small amounts, then we find

$$\frac{\Delta \mathrm{W}}{\mathrm{W}} = -\cot v \, \Delta v.$$

The ratio to the whole weight of any variation, produced by any such cause as recession from the centre of the earth, whether by climbing a mountain or by changing position on the terrestrial spheroid, will thus be determined by observations of v and its variation. Small variations of W may be determined if we give v a value approaching to 90°, and if we can observe small variations of v.

The following plan is being adopted for the purpose suggested. The weight, a cubic inch of lead, is suspended by two fine platinum wires; the cube has mirrors on three of its vertical faces, two of which are capable of adjustment so as to make an angle of about 86° with the middle mirror: below the cube a fine hair spring, like that of a watch balance, but of platinum (so as not to rust), is attached by one extremity to a central pin fixed below into the weight; the other extremity is fixed (when the weight hangs freely and the spring exerts no force) to a hollow cylinder which turns freely round the pin as a centre. In this ring another mirror is fixed parallel to the middle mirror of the weight, and immediately below and in front of it. A telescope is so placed that when the spring has no action on the weight, the central divisions of two scales (divided on glass) are seen reflected, one from the middle mirror of the weight, the other from the ring mirror at the same time. Such scales have been employed by the author with small sextant telescopes, for which one division equalled twenty seconds, and two seconds could be estimated.

Let us now suppose the two mirrors parallel, the spring exerting no action on the weight, and that the middle mirror faces the south. The observation commences by turning the ring (say directly) through an exact revolution, which is known by the mirror showing exactly the same scale division. The eastern mirror, which makes an angle of about 86° with the middle mirror, will now bring the scale into the field of the telescope (if the proper precautions have been taken by the maker, in adjusting the force of the spring and the interval of the wires to each other); and the scale division being made, the exact angle (v) through which the weight has been turned will be obtained. The ring should now be returned to its first position, and the observation repeated by turning the ring in the opposite direction (say retrograde) through a revolution.

It is evident that it is not necessary that the ring should be turned exactly through a revolution; it may be turned exactly a few degrees more or less by means of the scale, so that observations may be made with different values of v, and therefore with greater or less delicacy. Thus, as may easily be shown, when $v=86^\circ$, a variation in height of ten feet will be equivalent to a variation of three seconds; when $v=88^\circ$, the variation of three seconds will be produced by a rise of about five feet only. In proceeding from the poles to the equator, v should vary from 84° to 90° nearly.

The precautions taken to render the instrument portable, so as to keep the spring and wires with constant forces, the means of correcting for the effect of temperature, &c., need not be noticed till the completion of the instrument.

It should be pointed out as a great advantage of the instrument, that a large weight is not required, since it is the ratio of the variation of weight to the whole weight which is shown.

5. On the Law of Growth in Woody Circles of Exogenous Trees, as indicated by the Examination of a Single Specimen. By Principal Forbes.

The following Gentlemen were elected Ordinary Fellows:—

JOHN MUIR, D.C.L., Oxon.
WILLIAM TURNER, M.B.
W. LAUDER LINDSAY, M.D., F.L.S.

The following Donations to the Library were received:—

Proceedings of the Royal Horticultural Society. Vol. I., No. 20. —*From the Society.*

The Eruption, in May 1860, of the Kötlugjá Volcano, Iceland. By W. Lauder Lindsay, M.D., F.L.S. 8vo.—*From the Author.*

London University Calendar. 1861. 8vo.—*From the University.*

The Polar Regions. By Sir John Richardson, LL.D. Edinburgh, 1861. 8vo.—*From the Author.*

Illustrations of the Genus Carex. By Francis Boott, M.D. London, 1858. 2 vols. folio.—*From the Author.*

Bombay Magnetical and Meteorological Observations. 1858. Folio.—*From the Indian Government.*

Monday, 18*th February* 1861.

The HON. LORD NEAVES, V.P., in the Chair.

The following Communications were read:—

1. On the Embryology of Asteracanthion Violaceus (Linn. Sp.) By Wyville Thomson, LL.D., F.R.S.E., M.R.I.A., F.G.S., &c., Professor of Natural History in Queen's College, Belfast.

Early in December of the present winter, several specimens of *Asteracanthion violaceus* (L.) were procured, in the peculiar pregnant condition described by Sars. The disk was raised into a hump, and the rays drawn together at the base, to form the "marsupium" for the protection of the young. All the eggs or embryos in a single marsupium were at the same stage of development. In the least advanced, the eggs were undergoing the later stages of yelk-segmentation, while in others this process had been completed. In other individuals the embryos were partially or fully formed. A specimen, in whose pouch the mass of eggs were least advanced, was placed in a jar of sea-water, and the embryos were examined from day to day.

Segmentation appears to take place in this species in the way usual in the class, and involves the whole yelk. After segmentation, the embryonic mass is at first spherical, finely granular, and still invested by the vitelline membrane. This membrane soon disappears, and within a few hours the embryo seems perfectly homogeneous, regularly oval, and of a delicate flesh-colour. No trace of cilia could be detected at this stage on the surface. Four or five hours later, the oval form is still more marked; one end has become slightly dilated, and towards this end there is an accumulation of the granular substance. The whole embryo is now invested by a delicate structureless gelatinous layer, which is thinner and less apparent towards the narrower end of the oval. At the broader end it invests a dark consistent granular layer, of considerable thickness, formed of oil globules, and compound-granular masses and cells, which lines a central cavity, filled with a clearer granular semi-liquid, in which there are traces of molecular or ciliary motion.

The transparent investment of the narrow end now protrudes three tubular processes, two long and narrow, turned in one direction, and the third, shorter and thicker, turned in the opposite direction. Between these tubes in the centre there is a raised whitish imperforate tubercle. Each tube is dilated at the extremity into a slightly opaque rounded bulb, which at length takes the form of a sucker, undistinguishable from the ambulacral suckers of the young star-fish.

The granular fluid of the embryo still passes freely into the tubes through their wide common base.

This common base now contracts and lengthens; and this narrower portion of the clavate embryo is separated by a distinct line of demarcation from the broader mass, which gradually assumes a rounded and then a pentagonal form. The embryo during these changes increases rapidly in size. The peduncle, with its tubular appendages, now assumes its definite and final form—a wide transparent contractile tube, prolonged inferiorly into three, or sometimes four, wide tubular branches, terminated by suckers. The contents of the peduncle and tube-feet consist of a clear colourless fluid, in which chyle corpuscles, of the usual form, move and circulate with the motion peculiar to such particles in the vessels of the echinoderms. The embryo adheres by the suckers at the ends of the tubes to a foreign body, and moves along by the contraction and expansion of the three feet. The peduncle is attached to the lower surface of the rudimentary star-fish, slightly excentrically and midway between two of the rays. The star-fish, though now only about once and a-half the size of the peduncle, has asserted distinctly its echinoderm character. The pentagonal form is distinctly recognisable, and plates of the characteristic calcified areolar tissue have begun to appear in the external layer, both on the upper and the under surface. These plates assume a definite arrangement; and shortly a depression appears in the *centre* of the oral surface of the star-fish, and gradually deepens till it communicates with the central cavity of the body, forming the permanent mouth. Round the mouth a delicate tube forms an annular elevation, passing at one point under or into the base of the peduncle—the œsophageal circular vessel of the ambulacral system; and from this ring five delicate straight tubes pass to the ends of the rays, each tube flanked on either side by a row of rudimentary ambulacral suckers.

Up to this period, the general granular contents of the embryo could be forced by slight pressure into the tubes of the peduncle. Now, however, the attachment of the peduncle to the embryo gradually contracts, and at length it distinctly coalesces with, and becomes attached to, the annular ambulacral ring. Pressure applied to the peduncle no longer injects the general cavity of the star-fish; it only dilates its ambulacral vascular system. The true ambulacral system of the embryo now develops rapidly, assuming its proper locomotive and respiratory functions, and the peduncle withers—the sucking feet first breaking off, and the body of the peduncle disappearing finally, as a gradually contracting sac hanging to the ambulacral ring, midway between two of the rays. At the point of disappearance no scar is afterwards perceptible.

It would appear from the foregoing observations, that the first step in the development of this form of echinoderm embryo is the differentiation of a portion of the yolk into an investing layer of structureless "Sarcode;" that the layer gradually increases in thickness; and that finally, from one part of its surface, a branched peduncular process is produced, as an extension of the same transparent structureless material. The branches of this organ are terminated by suckers, and serve, among other functions, as organs of locomotion. When fully formed, they are undistinguishable in structure and function from the ambulacral feet of the star-fish; a fluid undistinguishable from the chylaqueous fluid of the ambulacral system moves in them with the same characteristic motion. The peduncle is closed externally, no communication, except by transudation, existing between its cavity and the surrounding medium. At first it communicates with the general cavity of the embryo, but afterwards it becomes connected with, and part of, the ambulacral circulating system. When the ambulacral vessels and suckers of the young star-fish become fully developed, this provisional vascular tuft disappears, leaving no apparent scar. In the species described, the peduncle is not connected in any way with the madreporic tubercle, which is not developed till long after its disappearance, and then on the opposite surface of the body.

The peduncular appendage seems to be essentially a provisional development of the ambulacral vascular system, and to be functionally analogous to the omphalo-mesenteric and umbilical vessels of the vertebrate groups, endowed, however, with a greater amount of versatility of function, corresponding to that of the peculiar vascular system of which it forms a part, and to a great degree dependent upon the peculiar vital properties of the substance entering into its structure.

2. Some Observations on the Albino. By John Davy, M.D., F.R.S. Lond. and Ed., &c.

The subjects of these observations were five individuals—four females, one male—all natives of Ceylon, of its south-east salubrious coast, and the children of coloured parents.

They are described by the author as well made, as having good health, and, though all coming under the denomination of Albinos, on account of their unusual fairness, yet as varying in degree, the lightest having red eyes and almost white hair; the less light, blue eyes and light-brown hair, with a complexion that in this country would be considered merely that of a pure blonde.

It would appear that the Albino in Ceylon, contrary to what has been asserted, is not held in contempt, but rather in respect, in accordance with the feeling of the people towards persons of high caste, who are almost invariably of a lighter hue than the more laborious and exposed low caste.

A speculation of the Singalese is mentioned relative to the white races, viz., that they are the descendants of Albinos, and, *ab origine*, merely an accidental variety.

The author seems to think that analogy is not unfavourable to this hypothesis, keeping in mind how great is the variety of colour, and its gradations from light to dark, amongst Europeans, and, in the instance of our domesticated animals, how colour is hereditary; and also on the ground that the sun's rays have a greater darkening effect on persons of brown skin than on those of fair; and that the former, especially the darkest—the blacks—are better able to resist malaria and the effects of tropical climates than the whites, and have thereby a better chance of escaping disease, and a premature death and extinction of race.

3. Note on the Bisulphide of Iodine. By Frederick Guthrie.

An examination of the action of certain compound halogens towards some of the olefines (the results of which I hope shortly to lay before this Society), has led me to consider incidentally the preparation of some of the compound halogens in the pure state.

Of compound halogens, while the constitution of none is more invariable and definite than that of the bisulphide of chlorine, the bisulphide of iodine can scarcely be said to have been prepared, despite the so strong analogy between chlorine and iodine.

That iodine combines with sulphur is well known; that such combination is attended by the liberation of heat, is equally well established. And since homogeneous mixtures of the two may be prepared in all proportions, it is clear that a substance having the percentage composition of the bisulphide of iodine may be formed. Bodies so formed have little or no title to the name of chemical compounds.

If we remember, on the one hand, the fact which I have abundantly proved elsewhere, that an equivalent of bisulphide of chlorine functions as two equivalents of chlorine, or, as some chemists would express it, that the molecule of bisulphide of chlorine is biatomic; and if we further remember, that at least two equivalents of chlorine or of zinc are required to recompose iodide of ethyl according to the equations—

$$(1.)^* \quad C_4H_5\,I + 2\,Cl = C_4H_5Cl + I\,Cl$$
$$(2.) \quad C_4H_5\,I + 2\,Zn = C_4H_5\,Zn + Zn\,I,$$

we must be prepared to anticipate the analogous recomposition—

$$(3.) \quad C_4H_5I + S_2Cl = C_4H_5Cl + S_2I.$$

This thè more, since in the case of certain compound groups, such as Na Sn, we find

$$(4.) \quad C_4H_5I + Na\,Sn = C_4H_5Sn + Na\,I.$$

The method I employ for the preparation of the bisulphide of iodine is, in fact, based upon the validity of equation (3). Recompositions quite akin to (3) are undergone by the iodides of methyl and of amyl, whence we may assert the general equation (5)—

$$(5.) \quad C_nH_{n+1}\,I + S_2\,Cl = C_nH_{n+1}\,Cl + S_2I.$$

For obvious reasons, the ethyl compound is preferred.

The reciprocal action of iodide of ethyl and bisulphide of chlorine is perhaps as interesting in its manner as in its result. The two liquids may be mixed in all proportions without a greater change in colour than is due to the dilution of the coloured sulphide by the colourless iodide; neither is heat liberated, nor other immediate token given of chemical change taking place. The change appears to be complete in about twelve hours. If the recomposition vessel be open to the air, the chloride of ethyl evaporates as it is formed, leaving the bisulphide of iodine in magnificent crystals, contaminated, however, by the products of the action of the moisture of the air upon the bisulphide of chlorine. For this reason the process is best conducted in a hermetically sealed tube. The co-reagents are used in the proportion shown by the equation, a very slight excess of the iodide being added.

On opening a tube so charged which has been left overnight, and applying the heat of the hand, the chloride of ethyl escapes. A gentle heat suffices to expel the residual iodide of ethyl, whereupon the bisulphide of iodine is left in the form of fine tabular crystals, of the lustre of iodine and in a state of absolute purity.

Although the exact composition of the substance may be fairly deduced from its synthesis, it was submitted to analysis in the following way:—0·3270 grms. were heated in a combustion-tube with nitrate of potash and carbonate of soda, whereupon the iodine and

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* Equation (1) expresses only the initial recomposition between chlorine and iodide of ethyl. The ultimate products are $I\,Cl_3$, along with hydrochloric acid and chlorine substitution products of C_4H_5Cl.

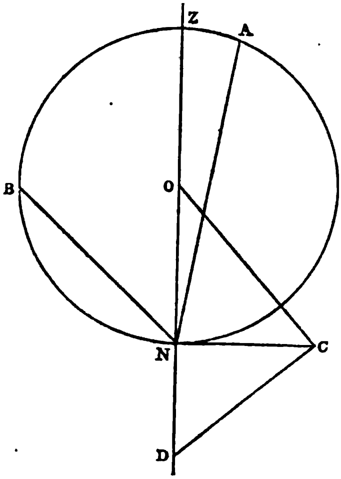
sulphur were converted respectively into iodide and sulphate of potassium, and estimated in the usual way.

		Calculated.	Found.
S_2,	.	20·13	20·28
I.	.	79·87	79.81
		100·0	100·9

Though in this note the recomposition is considered as a means of preparing the compound halogen S_2I, it is perhaps of equal interest as offering a method for obtaining an organic chloride from its iodide,—a problem otherwise difficult and cumbrous in solution, albeit its inverse is easy and of frequent occurrence.

4. Notice of an Expeditious Method (believed to be new) for Computing the Time of Descent in a Circular Arc. By Edward Sang, Esq.

In determining the intensity of gravitation from the oscillations of a pendulum, and in estimating the directive power of the earth's magnetism from the frequency of vibration of a needle, we have to make allowance for the extent of the arc through which the motions take place.



The formula usually given for this purpose contains a series converging rapidly enough for very small arcs, but which requires a great amount of labour when the angle of deflection exceeds twenty or thirty degrees.

My object is to give notice of a process by which the labour becomes insignificant.

Let O be the centre of motion, N the lowest point of the curve, and AN the arc through which the descent is to take place. Having drawn the horizontal tangent NC, make the angle NOC one-fourth part of NOA; through C draw CD perpendicular to OC meeting ON produced in D, and inflect the chord NB equal to twice ND; then the time of descent in the arc AN is to the time of descent in BN as OD is to ON.

By treating the arc BN in the same way, we can obtain a third arc, and so on, thus forming a series of arcs decreasing more and more rapidly as we proceed.

Let the angle NOA be denoted by $4A_0$, NOB by $4A_1$, the next angle of the series by $4A_2$, and so on; then we have, for any two consecutive terms of the progression,

$$(\tan A_n)^2 = \sin 2A_{n+1}, \qquad \text{and}$$

$$\text{time in } 4A_n = (\sec A_n)^2 \times \text{time in } 4A_{n+1}.$$

Now the time of descent in a small circular arc approaches to the time in a cycloidal one, and hence,

$$\text{time in } 4A_0 = \{\sec A_0 \times \sec A_1 \times \sec A_2 \times \text{etc.}\}^2 \times \text{time in cycloid.}$$

As an example of the ease and rapidity of the calculation, I subjoin the work for an angle of 160° from the nadir line, which shows that the time of oscillation in an arc of 320° is rather more than double of that in a minute arc.

A_n	2 Log sec A_n	2 Log tan A_n	2 A_{n+1}
° ′ ″			° ′ ″
40 00 00·000	·2314920670	9·8476270604	44 45 21·339
22 22 40·669	680053042	9·2292047378	9 45 34·359
4 52 47·180	31540158	7·8626575152	25 03·441
12 31·721	57684	5·1607141918	2·986
1·493	0		
	·3026571554	= log. 2·00750740.	

The progression may be put in another form, thus:—let t_0, t_1, t_2, &c., be the tangents of the angles A_0, A_1, A_2, &c.; then,

$$t_{n+1}{}^2 = \frac{1-\sqrt{(1-t_n{}^4)}}{1+\sqrt{(1-t_n{}^4)}} = \frac{t_n{}^4}{2+2\sqrt{(1-t_n{}^4)}-t_n{}^4}, \text{ the}$$

coefficient of correction being

$$(1+t_0{}^2)\,(1+t_1{}^2)\,(1+t_2{}^2), \text{ \&c.}$$

5. Note on a Modification of the Apparatus employed for one of Ampère's Fundamental Experiments in Electrodynamics.

By Professor Tait.

My attention was recalled by Principal Forbes's note (read to the Royal Society on January 7th), to his request that I should at leisure try to repeat Ampère's experiment for the mutual repulsion of two parts of the same straight conductor, by means of an apparatus which he had procured for the Natural Philosophy Collection in the University. Some days later I tried the experiment, but found that, on account of the narrowness of the troughs of mercury, it was impossible to prevent the capillary forces from driving the floating wire to the sides of the vessel. I therefore constructed an apparatus in which the troughs were two inches wide, the arms of the float being also at that distance apart. Making the experiment according to Ampère's method with this arrangement, I found one small Grove's cell sufficient to produce a steady motion of the float from the poles of the pile; in fact, the only difficulty in repeating the experiment lies in obtaining a perfectly clean mercurial surface.

Two objections have been raised against Ampère's interpretation of this experiment, one of which is intimately connected with the subject of Principal Forbes's note. This is the difficulty of ascertaining exactly what takes place where a voltaic current passes from one conducting body to another of different material. It is known that thermal and thermo-electric effects generally accompany such a passage. To get rid of this source of uncertainty, I have repeated Ampère's experiment in a form which excludes it entirely. In this form of the experiment the polar conductors and the float form one continuous metallic mass with the mercury in the troughs; the float being formed of glass tube filled with mercury, with its extremities slightly curved downwards so as nearly to dip under the surface of the fluid; and the wires from the battery being plunged into the upturned outward extremities of two glass tubes, which are pushed through the ends of the troughs so as to project an inch or two inwards under the surface of the mercury. A little practice is requisite to success in filling the float and immersing it in the troughs without admitting a bubble of air. This float, being heavier than the ordinary copper wire, plunges deeper in the fluid, and encounters more resistance to its motion, but, with two small Grove's cells only, Ampère's result was easily reproduced, even when the extremities of the float rested in contact with those of the polar tubes before the circuit was completed. It is obvious that here no thermo-electric effects can be produced in the mercury, and I have satisfied myself that the motion commences before the passage of the current can have sensibly heated the fluid in the tubes.

The other class of objections to Ampère's conclusion from this experiment, depending on the spreading of the current in the mercury of the troughs, is of course not met by this modification. I have made several experiments with a view to obviate this also, but my time has been so much occupied that I have not been able as yet to put them in a form suitable for communication to this Society.

The following Gentleman was admitted as a Fellow:—

James Lorimer, Advocate.

The following Donations to the Library were announced:—

On the Causes of Death in the Scottish Widows' Fund Life Assurance Society, from January 1853 to January 1860. By James Begbie, M.D., F.R.S.E.—*From the Author.*

Proceedings of the Royal Horticultural Society, Nos. VI. XVI., 1860; XXI., 1861.—*From the Society.*

Monthly Notices of Astronomical Society, Vol. XXI., No. 3.—*From the Society.*

Transactions of the Linnean Society, Vol. XXII., Part 4; XXIII., Part 1, 4to.—*From the Society.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. IV. 1860–61. No. 55.

Monday, 4th March 1861.

Professor CHRISTISON, Vice-President, in the Chair.

The following Communications were read:—

1. Memoir of the late Rev. Dr John Fleming. By Alexander Bryson, Esq.

2. On Zoological Classification, and the Parallelism of the Mammal, Marsupial, and Ornithic Classes. By Professor Macdonald.

The following Gentlemen were admitted as Fellows:—

Archibald Geikie, F.G.S.
William Handyside, Esq.

The following Donations to the Library were announced:—

Quarterly Journal of the Chemical Society. January 1861.—*From the Society.*

The Canadian Journal. January 1861.—*From the Canadian Institute.*

Recherches expérimentales sur l'electricité des metaux. Par A. T. Kupffer. Tome I. St Petersbourg, 1860. 4to.—*From the Academy of St Petersburg.*

Annalen der königlichen Sternwarte bei München. Band XII.—*From the Royal Observatory of Munich.*

Transactions of the Pathological Society of London. Vol. XI. 8vo.—*From the Society.*

Ofversigt af K. Vetenskaps Academiens Forhandlingar. Stockholm, 1860. 8vo.—*From the Academy.*

Descriptive Catalogue of the Fossil Remains of Vertebrata in the Museum of the Asiatic Society of Bengal. By Hugh Falconer, M.D. Calcutta, 1859. 8vo.—*From the Author.*

Bulletin de la Société Vaudoise des Sciences Naturelles. Tome VI. No. 47. Lausanne, 1860. 8vo.—*From the Society.*

Sitzungsberichte der k. Bayer. Akademie der Wissenschaften. München, 1860. 8vo.—*From the Academy.*

Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Tome XV. Part 2. Geneva, 1860. 4to.—*From the Society.*

Kongliga Svenska Vetenskaps-Academiens Handlingar 1858. 4to. —*From the Royal Academy of Stockholm.*

Kongliga Svenska Fregatten Eugenies, &c. Stockholm, 1859. 4to.—*From the same.*

Meteorologiska Jakttagelser i Sverige af Er. Edlund. 1859. 4to. *From the same.*

Journal of Asiatic Society of Bengal. No. 3. 1860.—*From the Society.*

Madras Journal of Literature and Science. October 1859 to March 1860. 8vo.—*From the Madras Literary Society.*

Abhandlungen der Akademie der Wissenschaften zu Berlin. 1859. 4to.—*From the Academy.*

Annales de l'Observatoire Physique Central de Russie. St Petersbourg, 1860. 4to.—*From the Observatory.*

Monday, 18*th March* 1861.

The Hon. LORD NEAVES, Vice-President, in the Chair.

The following Communications were read:—

1. On the Properties of the Secretion of the Human Pancreas. By William Turner, M.B. (Lond.), Senior Demonstrator of Anatomy, University of Edinburgh.

The author obtained the pancreatic secretion at a post-mortem examination which he made of the body of a patient of Mr Spence's, who had died with a medullary tumour in the head of the pancreas, which, by compressing the biliary and pancreatic ducts, had produced dilatation of the ducts of the liver and gall-bladder, as well as dilatation of the ducts and lobules of the pancreas. The secretion was contained in the dilated parts of the gland last named, from which it was drawn off by means of a pipette. The fluid thus obtained was of an orange-yellow colour, and well-marked viscid consistency—sp. gr. 1·0105; appearance slightly turbid, owing to the presence of small white flakes, which a microscopic examination proved to consist of groups of small spherical, colourless cells, resembling, and most probably consisting of, the epithelial lining of the vesicles of the gland. Reaction faintly yet decidedly acid; heat, alcohol, corrosive sublimate, and bichloride of platinum threw down copious yellowish-white precipitates, consisting of the peculiar albuminous constituent of the secretion. No reduction was effected by boiling the fluid with freshly precipitated blue oxide of copper, showing the absence of sugar or any corresponding deoxidizing substance. The absence of sulpho-cyanide of potassium was shown by no reaction being given with a solution of perchloride of iron; thus affording a well-marked distinction between the composition of the human saliva and pancreatic juice. A partial emulsionizing effect was produced by rubbing some of the fluid with a little oil. With another portion of the secretion, starch was converted into dextrine. The action of the fluid upon albuminous substances was also tested, but a negative result was obtained. It should be stated, however, that but a small quantity of the secretion was now left, and that a day had elapsed between its withdrawal from the body and the application of this test. The author then adverted to the accounts which have been given by various physiologists of the pancreatic fluid obtained from the different domestic animals which it is usual to experiment on when samples of this secretion are required, and concluded by showing in what respect the secretion of the human pancreas agreed with, or differed from, that of these animals.

2. On the Acrid Fluid of the Toad (*Bufo vulgaris*). By John Davy, M.D., F.R.S. Lond. and Edin., &c.

The author first adverts to the conflicting opinions respecting the nature of this fluid, and especially to one of the latest, that entertained by MM. Gratiolet and S. Cloez, that it is an active poison.

He next describes some experiments he has made for the purpose of testing their conclusion, the results of which are in opposition to theirs, and confirmatory of certain ones of his own, showing that the fluid is a simple acrid irritant, and as such well adapted to protect an animal otherwise defenceless, and, from its sluggish habits, peculiarly exposed to danger.

Incidentally, he makes some remarks on the toad of Barbadoes, which, brought from Dominica only a few years ago, has so multiplied as to abound in every part of the island. Its comparative rareness in Britain he attributes to two causes: one, the circumstance of the very young toad being, as he believes, destitute of the acrid fluid; another, the intolerance of the toad of all ages of severe cold, and in consequence, its liability to perish if the winter temperature be unusually low.

In a foot-note, he expresses the opinion, founded on one observation, that the female toad during the breeding season is without the protecting acrid fluid, the male at that time having it in more than ordinary abundance, and, from position, whilst the ova are *in transitu*, probably defending his mate.

3. On Gyrolite occurring with Calcite in Apophyllite in the Trap of the Bay of Fundy. By Henry How, Professor of Chemistry and Natural History, King's College, Windsor, Nova Scotia.

The mineral gyrolite was first described by Professor Anderson of Glasgow,* as a new species from the Isle of Skye; it is stated by

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* Trans. Roy. Soc. Edin., and Phil. Mag. Feb. 1851.

Greg and Lettsom[*] to occur without doubt at two localities in Greenland, and according to Heddle at Faröe. The only other notice of it that I am acquainted with is by L. Sæmann, who mentions[†] that he examined a specimen—no locality being given—mixed or interlaminated with pectolite, and suggests that this mineral, losing its alkali, becomes gyrolite, and, losing its lime, becomes okenite. No other analysis than the original one of Professor Anderson has, I believe, been published; the following account of its occurrence among the minerals of Nova Scotia shows it in such associations as affords a mode of explaining its origin by change in apophyllite.

I met with it in Annapolis Co., N.S., some 25 miles S.W. of Cape Blomida, between Margaretville and Port George, on the surface of fractured crystalline apophyllite, and, on further breaking the mass, a good many spherical concretions of pearly lustrous plates were observed in the interior, of sizes varying from that of a pin's head to nearly half-an-inch in diameter; their outline was well defined, and the external characters, as given by Anderson, were recognised on examination; it afforded the following results on analysis:—The mineral was ignited for water, and the residue treated with hydrochloric acid, the resulting dried silica was weighed, and then fused with carbonated alkali, and the weight of the small quantities of alumina, &c., so separated, was deducted from that of the first silica. I place my numbers by the side of those of Professor Anderson, and give the calculated percentages for his formula:—

	H. H.	Anderson.	Calculation.	
Potass, . .	1·60			
Magnesia, .	0·08	0·18		
Alumina, .	1·27	1·48		
Lime, . .	29·95	33·24	32·26	$2\,CaO = 56$
Silica, .	51·90	50·70	52.18	$2\,Si{\cdot}O_3 = 90{\cdot}6$
Water, . .	15·05	14·18	15·35	$3\,HO = 27$
	99·85	99·78	99·99	173·6

and a general accordance is observed sufficient to show the identity of chemical composition in the minerals examined; the small quantity of potass present in my specimen probably modified the blowpipe characters a little, as I found it not to exfoliate completely, and it fused without any difficulty, and even with some boiling.

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[*] Manual of Mineralogy, p. 217.

[†] First Supp. to Dana's Mineralogy, p. 9. Silliman, May 1855.

Some of the numerous cavities in the apophyllite were empty, some entirely filled with gyrolite, and in others separate plates of this mineral were standing edgewise, leaving vacant spaces, while, upon and by the side of the plates were in some cases rhombohedral crystals, which proved to consist of calcite, and were sometimes present alone in the cavities, which varied from being quite shallow to half-an-inch in depth. It is mentioned by Anderson that gyrolite occurs associated with stilbite, laumonite, and other zeolites, and is sometimes found coating crystals of apophyllite.

The difference in chemical composition between apophyllite and gyrolite is very well seen on comparing the respective theoretical percentages of their constituents; thus,

	$Si \cdot O_3$.	CaO.	KO.	HO.
Apophyllite,	=52·70	26·00	4·40	16·70+ HF variable;
Gyrolite,	=52·18	32·26		15·50;

and the existence of the calcite in the cavities seems clearly to show, that the gyrolite is formed from the apophyllite by the action of the water which deposited the carbonate of lime, reacting on the silicate of potass, and dissolving out at the same time the fluorine or fluoride of calcium;[*] trial was made for fluorine on two fragments of the gyrolite, and no evidence of its existence obtained.

4. On Natro-boro-calcite, and another Borate occurring in the Gypsum of Nova Scotia. By Henry How, Professor of Chemistry and Natural History, King's College, Windsor, N.S.

About three years and a half ago, I showed the existence of Natro-boro-calcite in the gypsum of Windsor, N.S.[†] I was not aware at that time that Dr Hayes of Boston, U.S., had announced his conviction[‡] that the soda which had been attributed to this mineral was an impurity, and had given, as the true expression of the composition of the pure mineral, the formula $CaO\ 2\,BO_3 + 6\,HO$. Had I known this, I should have adverted to the probability of his mineral (Hayesine, Dana) constituting a distinct species from Natro-boro-calcite, whose existence seems to be sufficiently established by the repeated finding of not very dissimilar quantities of soda in analyses

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[*] Dana's Mineralogy, i. p. 332, 333.

[†] Edin. New Philosophical Journal, July 1857. Silliman, Sept. 1857.

[‡] Silliman, Nov. 1854, p. 95.

of specimens from two of its three localities, as seen in the following list, which contains all the analyses I have been able to find :—

	BO_3.	CaO.	HO.	NaO.	KO.	SO_3.	NaCl.	Sand.	
Peru, .	46·11	18·89	35·00						Hayes[*]
Tuscany, .	51·135	20·85	26·25						Bechi[*]
Peru, .	49·50	15·90	25·80	8·8					Ulex[†]
Peru, .	49·50	17·70	26·00	8·8					„ [†]
„ .	45·46	14·32		8·22	0·51	1·10	2·65	0·32	Dick[*]
„ .	43·70	13·11	35·67	6·67	0·83				Ramm.[‡]
„ .	47·25	15·98	25·46	9·88		0·45		0·98	Anderson[§]
Nova Scotia,	41·97	13·95	34·39	8·36		1·29	MgO	0·04	H. How[*]
„	44·10	14·20	34·49	7·21					„

In the account of the analysis by Anderson, the quantities of soda and sulphuric acid, as given above, are reversed ; from the conclusion drawn by the author, this is evidently a typographical error. As regards the amount of water present, no mention is made, in any case but my own, as to the temperature at which the substance was dried ; in my analysis the mineral was air-dried. The soda, it will be observed, is a constant ingredient, in pretty uniform amount, in all but the first two analyses ; and in my, examination as stated at the time, the mineral was washed, for the second analysis, with cold water till all sulphuric acid was removed.

From the preceding data the following formulæ have been deduced :—

$CaO\ 2\ BO_3 + 6\ HO$	Hayes ;
$NaO\ 2\ BO_3 + 2\ CaO,\ 3\ BO_3 + 10\ HO$.	Ulex ;
$NaO\ 2\ BO_3 + 2\ CaO,\ 3\ BO_3 + 15\ HO$.	H. How ;
$NaO\ 2\ BO_3 + 2\ (CaO\ 2\ BO_3) + 18\ HO$.	Rammelsberg ;

all referring to a mineral found in rounded masses, consisting of interwoven fibres, opaque, snow-white, and of a silky lustre.

The mineral to which I would now draw attention was found in the same quarry as the preceding, at a distance of about 100 yards, and at about 20 feet lower level, and also associated with glauber-salt, which, it is worthy of notice, is generally met with here, according to the quarrymen, in narrow seams at the line of junction of the "hard plaster" (anhydrite) with the "soft plaster" (gypsum). I detected it in the form of an opaque white substance without lustre,

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[*] Dana's Min., 4th ed., p. 394.

[†] Liebig und Kopp's Jahrb. 1849, p. 780.

[‡] Silliman, Sept. 1856, 3d Supt. to Dana's Min., p. 6.

[§] Proc. Phil. Soc. Glasgow, Feb. 1853.

and, to the naked eye, devoid of crystalline structure, in cakes and somewhat rounded masses, varying in size from that of a small pea to that of a bean; these masses lay between gypsum and crystals of glauber-salt, taking shape from the crystals of the latter on the side next to them, and, when detached from them, leaving their faces, as it were etched, and sometimes the crystals were penetrated to a considerable depth by the imbedded borate. The mineral is very soft, $H=1$, but coherent, tasteless, slightly tough between the teeth, fuses readily before the blowpipe to a clear bead, insoluble in water, soluble in hydrochloric acid. As found, or very soon after being brought home, it lost by exposure to the air,—

Water = 18·36 per cent.,

and the air-dried substance gave the following results on analysis; the water was determined by ignition; the lime, magnesia, and sulphuric acid in one portion of the so dried residue, and the soda in another, after its treatment with fluor-spar and sulphuric acid for elimination of boracic acid, which was, of course, estimated by deficiency:—

	I.	II.
Lime, ...	14·21	
Soda, ...	7·25	
Sulphuric acid, . . .	3·98	
Magnesia, . . .	0·62	
Water, ...	19·96	20·78
Boracic acid, . . .	53·98	
	100·00	

The quantity of mineral obtained did not permit me to make more than one analysis and retain a little as a specimen for identification; but these results, as well as the characters already mentioned, and the crystalline structure to which I shall presently advert, are, I think, sufficient to show that it is specifically distinct from Natro-boro-calcite (see analyses, p. 429). On the assumption that the magnesia and sulphuric acid are accidental, and that the latter is combined with the former, and with a quantity of soda equivalent to that of the acid not required by the magnesia, I have calculated the preceding results (I.) after making these deductions, and at the same time taking away the amount of water necessary to render the $MgO\ SO_3 = MgO\ SO_3 + 7$ aq. (the hydrated sulphate of soda would of course, become anhydrous on exposure to dry air); the results then become:—

	Oxygen.	Ratio.	Calculation.		
Lime, . .	15·55 = 4·44	3·08	3 CaO	84	15·46
Soda, . .	5·61 = 1·44	1	NaO	31	5·77
Water, . .	19·72 = 17·52	12·16	12 HO	108	20·11
Boracic acid, .	59·10 = 40·47	28·10	9 BO_3	314·1	58·48
	99·98			537·1	100·00

—corresponding to the formula,

$$NaO,\ 3\ CaO,\ 9\ BO_3 + 12\ HO.$$

I am very well aware that it is unsafe to base a formula upon a single analysis, especially of a mineral substance, and most especially after making deductions as above, and I cannot, in this case, insist on the one brought out, but it is not anomalous. We find rather complex combinations both in the natural and artificially formed compounds of boracic acid; thus,

Hydroboracite,* = $3\ CaO,\ 4\ BO_3 + 3\ MgO,\ 4\ BO_3 + 18\ HO$, and
Larderellite,* = $NH_4O,\ 4\ BO_3 + 4\ HO$;

while Laurent describes† a salt = $5\ NaO,\ 24\ BO_3 + 52\ HO$, and Rose one‡ = $3\ CaO,\ 5\ BO_3$ when ignited; and it is a little curious that the formula given above includes the soda compound corresponding to Larderellite and the salt of Rose—

$$NaO,\ 4\ BO_3 + 3\ CaO,\ 4\ BO_3 + 12\ aq.$$

I mentioned that the mineral presented no appearance of crystalline structure to the naked eye. Not having at hand, at the time I was at work upon it, a sufficiently good microscope, I sent a portion of the mineral to Professor Robb, of the University of New Brunswick, at Fredericton, with a letter stating my results and my doubt as to the substance being crystalline. I received this answer—"In spite of your odd formula, the mineral just as I got it, untouched and unwashed, is perfectly crystalline in every particle. A good power is required; but with a magnifying power of about 350 diameters there is no difficulty, the form comes out as sharp as possible. The crystals are excessively thin translucent tables or plates. They have a rhombic outline, and the angles probably = 80° or more,

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* Dana's Min., 4th ed., 394, 395.

† Liebig und Kopp's Jahresbericht, 1849, p. 226.

‡ Ibid., 1842, p. 313.

Owing to their excessive thinness I could not say whether they could be called right or oblique rhombic prisms; I suspect the latter from analogy. By care the 'Tiza' (Natro-boro-calcite) can be shown to consist of very fine prisms, sharp, angular, and long, but too fine for me to state their form. The diameter was less than ·00118 of an English inch. The long prismatic needles of the Tiza are in great contrast to the broad tables of the recent mineral in your last letter; of that the plates are about ·0048 of an inch from side to side, but some are a little larger, others a little smaller. In some you see regular cleavage—that is, a small rhomb chipped out of one side. As far as form goes, therefore, it would seem to be a distinct and definite species. I presume it was formed in a dry place, for the angles were quite sharp. The connection between these borates and sulphates of lime and sulphate of soda is very curious."

I may state that I had subsequently the opportunity of appreciating the great accuracy of this description of the appearance of the two minerals.

Arguing from the chemical composition, which, however, may not be quite established, and the crystalline structure, I conceive the mineral in question to constitute a new species, and I propose for it the name of Cryptomorphite (*κρυπτος* occultus, and *μορφη* forma), in allusion to its microscopic crystalline structure.

The truth of the last sentence in Professor Robb's letter is very apparent. In my former paper on the subject, I adverted to the existence of Natro-boro-calcite in the gypsum here, as confirming Dawson's theory of the origin of the rock from the action of volcanic waters on carbonate of lime. It is interesting to observe that Bechi* found the same (?) mineral, with other borates, in the lagoons of Tuscany. The hydrated condition of both the borates found here, and of the associated sulphate of soda, shows the action of water; but that of ordinary sea-water would not account for the presence of boracic acid. As regards the soda, the sulphate and borate of lime were probably the substances originally present, and chloride of sodium in water being introduced might remove part of the calcium as chloride, and furnish borate and sulphate of soda. It is confirmatory of this view that a small quantity of rock-salt in crystalline grains has recently been found in the gypsum.

* Dana's Min., 4th ed., pp. 394, 395.

5. On some Derivatives from the Olefines. By Frederick Guthrie, Professor of Chemistry and Physics in the Royal College, Mauritius.

This paper is supplementary to, and forms the sequel of, a series of papers which have been published in the "Quarterly Journal of the Chemical Society of London."

In continuing the examination of the behaviour of the olefines towards compound halogens, certain compounds previously described have been submitted to a test of homogeneity, of which the following is the principle:—

"If a body be partly dissolved in a solvent, and if the dissolved part and the undissolved part, or the dissolved part and the whole, or the undissolved part and the whole, have the same composition, then the body is a simple one."

Examined in this manner with regard to the solvent alcohol, the bisulphochlorides of ethylen and amylen were shown to be true chemical compounds.

The bisulphochloride of ethylen was submitted to the action of chlorine, whereupon a body was formed identical with that got by the action of chlorine upon the bisulphochloride of chlorethylen or upon the bisulphide of ethyl—namely, the chlorosulphide of bichlorethylen or sulphide of terchlorethyl

$$C_4\ H_2\ Cl_3\ S.$$

Further, the same body $C_4\ H_4\ S_2\ Cl$ was submitted, in alcoholic solution, to the action of hydrate of potash, which converted it into

$$C_4\ H_4\ S_2\ OHO.$$

Again, the body $C_{10}\ H_{10}\ S_2\ Cl$ (whose equivalent of chlorine has been shown to be replacible by O and by OHO), on treatment with cyanide and sulphocyanide of potassium in alcoholic solution, exchanges its chlorine for cyanogen or sulphocyanogen respectively, giving rise to

Bithiocyanide of amylen, $C_{10}\ H_{10}\ S_2\ Cy$
and Bithiosulphocyanide of amylen, $C_{10}\ H_{10}\ S_2\ S_2\ Cy$

respectively.

From these and analogous reactions previously described, the conclusion is drawn that the bodies $C_4\ H_4\ S_2\ Cl$ and $C_{10}\ H_{10}\ S_8\ Cl$

behave towards chlorine like the sulphides of chloriniferous radicles,

$$C_4\left.\begin{matrix}H_4\\Cl\end{matrix}\right\}S_2 \qquad C_{10}\left.\begin{matrix}H_{10}\\Cl\end{matrix}\right\}S_2;$$

while towards metallic oxides, hydrated oxides, cyanides, and sulphocyanides, they behave like chlorides of sulphuriferous radicles,

$$C_4\left.\begin{matrix}H_4\\S_2\end{matrix}\right\}Cl \qquad C_{10}\left.\begin{matrix}H_{10}\\S_2\end{matrix}\right\}Cl.$$

The bisulphide of amylen,

$$C_{10}\,H_{10}\,S_2,$$

was produced by the withdrawal of the chlorine from $C_{10}\,H_{10}\,S_2\,Cl$ by means of metallic zinc—a reaction analogous to the reduction of kakodyl from its chloride.

The bichloride of amylen,

$$C_{10}\,H_{10}\,Cl_2,$$

could not be formed by the direct union of chlorine and amylen, but was produced by the action of amylen upon the pentachloride of phosphorus.

The binitroxide of amylen,

$$C_{10}\,H_{10}\,2NO_4,$$

which is formed in small quantity when nitric acid and amylen react on one another, was formed in abundance when NO_4 was led into amylen. This reaction shows how completely NO_4 obeys the laws of the halogens, and leads to its being called nitroxine. The same property is again illustrated by the conversion of the latter body into bicyanide of amylen,

$$C_{10}\,H_{10}\,Cy_2 + 5Aq,$$

by the action of cyanide of potassium in alcoholic solution, the nitrite of potash or nitroxide of potassium KNO_4 being formed at the same time. The five equivalents of water are feebly combined. An experiment to procure the pimelate of potash from the bicyanide of amylen by the action of caustic potash was without result.

By the action of nitric acid upon the bisulphochloride of amylen the nitroxisulphide of nitroxamylen is formed,

$$C_{10}\begin{matrix}H_9\\NO_4\end{matrix}SNO_4,$$

together with a conjugate sulphur acid.

Finally, when zinc-ethyl and bisulphochloride of amylen are brought together in ethereal solution, the chlorine of the latter body is replaced by ethyl, and a body formed having the constitution and properties of the bisulphide of œnanthyl—

$C_{10} H_{10} S_2 C_4 H_5$ Bisulphethide of amylen,
or $C_{14} H_{15} S_2$ Bisulphide of œnanthyl.

A list is given of the compounds hitherto obtained by the action of certain compound halogens upon the olefines ethylen and amylen.

The use of the terms Recomposition, Isotype, Idiotype, are explained, and a method given for determining the specific gravity of small quantities of liquids, which are heavier than and insoluble in water.

The following Gentleman was admitted an Ordinary Fellow:—

George Berry, Esq.

The following Donations to the Library were announced:—

Proceedings of the Royal Horticultural Society, Vol. I., No. 21. —*From the Society.*

Monthly Notices of Astronomical Society, Vol. XXI., No. 4.—*From the Society.*

Journal of Royal Dublin Society, Nos. 18 and 19.—*From the Society.*

Journal of Agriculture, March 1861.—*From the Highland Society.*

On a new genus of Echinoderms, and Observations on the genus Palæchinus. By Fort-Major Thomas Austin, F.G.S.—*From the Author.*

Quarterly Return of Births, Deaths, and Marriages registered in Scotland, for quarter ending 31st December 1860.—*From the Registrar-General.*

Journal of Royal Geographical Society, Vol. XXX., 1860. 8vo.—*From the Society.*

A Lunar Tidal Wave in Lake Michigan demonstrated. By Brevet Lieut.-Colonel J. D. Graham.—*From the Author.*

Fortschritte der Physik im Jahre 1858. Berlin, 1860.—*From the Physical Society of Berlin.*

Les Libre Echangistes et les Protectionistes Conciliés. Par J. Du Mesnil-Marigny. Paris, 1860.—*From the Author.*

The Mathematical Works of Isaac Barrow. Edited by W. Whewell. Cambridge, 1860. 8vo.—*From the Editor.*

On the Structure of the North-Western Highlands. By James Nicol, F.G.S., F.R.S.E.—*From the Author.*

Schriften der Universität zu Kiel, 1859.—*From the University.*

Transactions of the Philosophical Institute of Victoria, Vol. IV., Part 2. Melbourne, 1860.—*From the Institute.*

Journal of Statistical Society of London, March 1861.—*From the Society.*

Monday, 1*st April* 1861.

DR CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. On the Molecular Theory of Organization. By Professor Bennett, M.D., F.R.S.E., &c.

Parodying the celebrated expression of Harvey, viz., *Omne animal ex ovo*, it has been attempted to formularise the law of development by the expression *omnis cellula e cellula*, and to maintain "that we must not transfer the seat of real action to any point beyond the cell."[*] In the attempts which have been made to support this exclusive doctrine, and to give all the tissues and all vital properties a cell origin, the great importance of the molecular element, it seemed to the author, had been strangely overlooked. It becomes important, therefore, to show that real action, both physical and vital, may be seated in minute particles, or molecules much smaller than cells, and that we must obtain a knowledge of such action in these molecules if we desire to comprehend the laws of organization. To this end the author directed attention: 1*st*, To a description of the nature and mode of origin of organic molecules; 2*d*, To a demonstration of the fact that these molecules possess inherent powers or forces, and are present in all those tissues which manifest vital force; and 3*d*, To a law which governs the combination, arrangement, and behaviour of these molecules during the development of organised tissue.

I. By a *molecule* was understood a minute body, seen under high magnifying powers in all organic fluids and textures, varying in size from the four-thousandth of an inch down to a scarcely visible point, which may be calculated at much less than the twenty-thousandth of an inch in diameter. Optically it is distinguished according to its size—the smallest presenting dark or light points as the focus is changed, and the larger exhibiting a dark or light centre,

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[*] Virchow, Eng. Trans. p. 3.

surrounded by a distinctly shadowed ring. These last are frequently distinguished by the name of *granules*. The ultimate molecule had never been reached even with the highest magnifying powers. In the same manner that the astronomer with his telescope resolves nebulæ into clusters of stars, and sees other nebulæ beyond them, so the histologist with his microscope magnifies molecules into granules, and sees further molecules come into view. The chemical composition of these molecules must vary infinitely, but the author had been in the habit of classifying them into three groups and referring them to, 1*st*, the albuminous, 2*d*, the fatty, and 3*d*, the mineral compounds. These constituents may be mingled together in various proportions, so as to produce simple and compound molecules. In the vast majority of cases they are globular in shape, but they may be angular, square, and of various forms. They may differ in size or be of tolerably uniform size in the same liquid or substance. They may be regularly or irregularly diffused in the matter examined. Sometimes they are concentrated in particular places, and at others scattered in groups. Their colour is various. Most of the pigments in plants and animals are dependent on the formation of molecules, which in the human lung have been proved to be pure carbon, and in the tissues of plants and animals differently tinted kinds of fat or of wax.

These molecules may be formed in two different ways,—1*st*, by precipitation in fluids; 2*d*, by the disintegration of previously formed tissues. The former may be called *histogenetic* (ἱστος and γένεσις, *generatio*), and the latter *histolytic* (ἱστος and λυσις, *dissolutio*). They may be denominated molecules of formation and molecules of disintegration.

Histogenetic molecules are formed either from the union of two simple organic fluids or from precipitations occurring in formative fluids, holding various substances in solution. Fourteen years ago the author read to the Society a paper giving an account of the results obtained by a union of oil and liquid albumen, the two organic fluids from which molecular matter is most commonly derived. It was Dr Ascherson of Berlin, who first discovered the important fact, that the mere contact of oil and fluid albumen caused the latter to coagulate in the form of a membrane, which he called the haptogen membrane, from 'Απτομαι to come in contact. A more complete mixture of two such drops produces, as is well known, a white opaque fluid or emulsion, which in structure exactly resembles milk. That is to say, it consists of molecules composed of a drop of oil surrounded by a layer or membrane of coagulated albumen. Such compound molecules possessing the property of endosmose may therefore readily be produced artificially, and by trituration can be reduced in size so as to resemble the elementary molecules in chyle or in the yolk of the egg. If oil and albumen be introduced into the stomach and intestinal canal, they are always so reduced; and one of the objects of digestion would appear to be separating from the food, and rendering fluid its oil and albumen, so as to produce the chyle molecules which are ultimately transformed into blood. Indeed, everywhere in living organisms it may be observed, that oil and albumen formed as secretions by plants, and entering the bodies of animals as food, either separately or united, constitute the chief origin of molecular formations.

Mr Rainey has recently pointed out the condition which causes molecular mineral matter to assume the form of rounded nuclear bodies.* This condition is viscosity. If carbonate of lime be dissolved in water, the forms produced on its precipitation are crystalline; but if the fluid be glutinous, composed, for example, of fluid, gelatine, or gum, the forms produced are oval or globular. Precipitations made in this way on slides of glass, closely resemble the appearances called nuclear or cellular in different stages of development. Mr Rainey has further shown how starch granules are produced in the juices of vegetables by the endosmose of gum into a cell containing a solution of dextrine.† In the same manner that the contact of oil and albumen produces oleo-albuminous molecules, so does the contact of gum and dextrine precipitate starch molecules. In this manner we can comprehend how the mixture of various organic fluids gives rise to particles of different kinds.

Histolytic molecules are the result of the transformation and disintegration of fluid and solid substances by chemical or mechanical action. They are generally larger in size than histogenetic molecules, are more purely fatty, and from being associated with the debris of broken-down texture may, in most instances, readily be distinguished. Thus, in the breaking up of cells and of muscles when they become fatty,

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* On the Mode of Formation of Shells of Animals, of Bone, and of several other Structures, by a process of Molecular Coalescence, &c. By George Rainey, M.R.C.S. London, 1858.

† Microscopical Journal, 1859.

or in the putrefaction of vegetable or animal matters, these may be seen to soften, lose their peculiar structure, break up, and ultimately be reduced to a molecular condition.

We shall subsequently see that these two kinds of molecules are constantly changing places, or, in other words, molecular matter formed from the process of disintegration may, when placed under peculiar circumstances, become the basis of matter which undergoes development. In nature, the breaking down of one substance is the necessary step to the formation of another, and the histolytic or disintegrative molecules of one period become the histogenetic or formative molecules of another. This fact constitutes the basis of the law which I shall subsequently seek to establish.

II. The author pointed out, in the second place, that these molecules are governed by forces, which induce among them a variety of movements, and cause them to combine in definite ways. This force, which we may call *molecular force*, is altogether independent of cell, nucleus, or other form of structure.

1*st*, He alluded to the well-known molecular movements described by Robert Brown. These vibratile, circular, serpentine, or irregular motions may be observed whenever molecules are suspended in fluids of certain densities, but are too well known to require notice here. They occur altogether independent of organised structures, and must be regarded as in their nature purely physical.

2*d*, The peculiar movements observed in the interior of cells vegetable or animal, and during the putrefaction of organic matter. The former are seen in the large vegetable cells of the Chara, Vallisneria, and Tradescantia, among plants; and those of chyle, the yolk of the egg, and of the salivary cell among animals. The author had frequently watched the formation of the latter in putrid fluids. A scum composed of molecules collects on the surface; gradually several of these unite in minute filaments more or less long, which assume vibratile or serpentine movements. They are then called *vibriones*. It has been much disputed whether this class of molecular motions be physical or vital.

3*d*, The movements which are unquestionably vital that occur in the molecules of the yolk, on the entrance into the ovum of the spermatozoid. Here it cannot be maintained that the results are purely physical, because in different ova we see such widely varying effects from apparently the same cause. Neither can it be attributed to any direct influence of the cell or of its nucleus, the germinal vesicle. For example, an egg is fully maturated in the female organs of generation, and would prove abortive if a spermatozoid did not find its way through the zona-pellucida and get among the molecules of the yoke. As soon as it does so, the apparently purposeless Brunonian movements receive a new impulse and direction. Both spermatozoid and germinal vesicle are dissolved among them, and that wonderful phenomenon of the division of the yoke takes place, not by cleavage or other action of the cell wall or nucleus, but by the separation of the mass into two masses instead of one. This was compared to what is observable in a dense crowd of men, called upon to pass over to the right or left hand in order to settle any disputed question by a majority. At first unusual confusion is communicated to the whole; some hurry in one direction, others in another; but after a time there is seen at the margins, where the crowd is least dense, a clear space, which gradually approaches the centre, and at length bisecting the whole, produces a complete segregation of the crowd into two portions. So with the molecules of the yolk in the egg after impregnation; their movements are directed by conditions which did not previously exist, and a stimulus is imparted to them which causes the peculiar result. It is the division and subdivision of the yolk, wholly or in part, which produces the germinal mass out of which the embryo is formed, and this not by any direct influence of the cell or nucleus, but in consequence of a power inherent in the molecules themselves, which was communicated to them for a specific purpose.

4*th*, The peculiar movements so well described by Brücke, Von Wittich, Harless, and especially by Lister, in the pigment cells of the frog's skin;* and which occasion the sudden change of colour in the cameleon, in fishes, and numerous other animals. The black pigment molecules may be diffused throughout the cell or concentrated in a mass, and all kinds of intermediate gradations may exist between diffusion and concentration. The change in colour is owing to these alterations in the molecules, the tint being light when they are concentrated, and dark when they are diffused. Mr Lister ascertained by experiment that their concentration is caused by ex-

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* On the Cutaneous Pigmentary System of the Frog.—Philosophical Transactions, 1858.

posure to light, by death of the animal, and by sudden section of the nerve going to the skin—while darkness and irritation of the nerve or skin causes diffusion. Sudden amputation of a limb produced at first diffusion, followed by the concentration of death. These movements of the pigment molecules are peculiarly vital, and altogether independent of the cell wall or nucleus. The cell wall is stationary, and acts only as a sac or investing membrane around the moving particles, while the concentration of these about the nucleus is purely accidental, and frequently occurs in other parts of the cell. The author had seen these molecules himself, as Mr Lister describes them, streaming out to and returning from the circumference under the influence of the stimuli referred to, where no cell nor nuclear action could be thought of.

5*th*, There are many other kinds of movements which are evidently independent of cells: for example, those of cilia and of spermatozoids. The former are outside cells, and the latter only move when they are liberated from cells. The contractile fibrillæ of muscle are evidently not dependent for their inherent power on cells or other form of structure, but on the square-shaped molecules of which its substance is composed. All these phenomena, therefore, are connected with the molecules themselves; the force occasioning them is a molecular force, and has nothing to do with pre-existing cells, or supposed germinal centres, as some have imagined.

Again, the power of combination between these molecules, which, under peculiar conditions, not only move, but so move as to advance towards and press upon each other, that they at length unite and produce higher forms, must also be attributed to a molecular force operating in obedience to fixed laws. Thus it was demonstrated by Newton, that in a sphere the total attraction resulting from the particular attraction of all its component parts, is, as regards any body drawn towards it, the same as if they had been concentrated at the centre. Hence minute spherical particles, as so many gravitating points, will be drawn towards each other with a force varying inversely as the squares of the distances between their respective centres. The author referred at length to the able descriptions of Mr Rainey,* as to the physical laws regulating the formation and disintegration of bodies by molecular attraction and repulsion as well as to the effects of molecular superposition, showing that the same

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* *Op. cit.* See also papers in the Microscopical Journal, 1860.

physical power which leads to the formation of these artificial bodies, when long continued, causes their disintegration and destruction. All these changes occur slowly, and require time; but their contemplation, when regarded as purely physical phenomena, must strike us with surprise, as being closely allied to all our conceptions of the progress of life itself.

Here the author explained, that in making use of the expressions *life* and *vital action*, he was only using terms to indicate phenomena which, in the present state of science, cannot be accounted for by the ordinary laws of physics. Or it might be said that certain actions are directed and governed by conditions which are as yet undetermined, but which, as they only occur in organic, as distinguished from inorganic bodies, constitute vital actions. Not that an organised body is independent of physical forces, but that certain directions are communicated to them; which, as invariably resulting in specific forms or properties, make up the sum of what we call vitality.

Hence, although we see molecules combining in the forms of crystals and nucleated spherules, inasmuch as we have discovered the physical conditions on which they depend, and can produce them artificially, we have no difficulty in classifying these among purely physical phenomena, even when they occur in the interior of animals. But when other molecules unite to form nuclei, cells, and fibres, and these arrange themselves into tissues and organs to produce plants and animals, we are ignorant of the conditions by which these results are brought about—we cannot imitate them artificially, and are content to call them vital. But the fact the author was anxious to point out was this, that so far as observation and research had enabled us to investigate this difficult matter, it would appear that the formations and disintegrations of vegetables and animals, as well as the peculiar properties they exhibit, are essentially connected with the molecular element. Thus, when we investigate the functions of plants and animals—for example, generation, nutrition, secretion, motion, and sensation,—we find them all necessarily dependent on the permanent existence and constant formation of molecules.

Thus generation, both in plants and animals, is accomplished by the union of certain molecular particles called the male and female elements of reproduction. Among the Protophyta, the conjugation of two cells enables their contents, or the endochrome, to mix together. This endochrome is a mass of coloured molecules, and the union of two such masses constitutes the essential part of the generative act. In the Cryptogamia, a vibratile antheroid particle enters a germ cell, and finds this last filled with a mass of molecules which, on receiving the stimulus it imparts, assumes the power of growth. It is the same among the Phanerogamia, when the germ-cell is impregnated by the pollen tube. In all these cases it is necessary to remember that the protoplasm is a mass of molecules; that a spore is another mass of molecules; that sporules are molecules; that antherozoids are only molecules with vibratile appendages; and that the so-called germinal matter of the ovule is also nothing but a mass of molecules. Cell-forms are subsequent processes, and once produced may multiply endogenously, by gemmation or cleavage; all that is here contended for is, that the primary form is molecular, and that the force-producing action in it is a molecular force.

In animals, as in vegetables, every primary act of generation is brought about by the agency of molecules. The Protozoa entirely consist of mere molecular gelatiniform masses, in which it has never been pretended that a cell wall or central cell exists. And yet such masses have the power of independent motion, and of multiplying by gemmation. Considerable discussion has occurred as to whether, among Infusorians, there is a union of sexes or a conjugation similar to what occurs among the Protophyta; but in either case, it is by molecular fusion that the end is accomplished. In the higher classes of animals there are male elements, consisting of molecules, generally with, but sometimes destitute of, vibratile filaments, and female elements, composed of the yolk within the ovum, containing a germinal vesicle or included cell. Both spermatozoid and germinal vesicle are dissolved in the molecules of the yolk, which then, either wholly or in part, by successive divisions and transformations, constitute a germinal mass out of which the embryo is formed. Here, as in plants, it is necessary to remember that the spermatozoids, the yolk, and the germinal mass, are all composed of molecules, and that these, combining together, form the nuclei, cells, fibres, and membranes which build up the tissues and organs of the organism. It is not from either the male or the female element that the embryo is formed. The supporters of an exclusive cell doctrine have endeavoured to show that there is always a direct descent either from the wall of the ovum or from the germinal vesicle as its nucleus. Thus some consider that the vitelline membrane sends in partitions to divide the yolk mechanically. Others have formed the idea that the germinal vesicle bursts, and that its included granules constitute the germs of those cells which subsequently form in the germinal mass. Others, again, suppose that on impregnation the germinal vesicle divides first, and that the molecules of the yolk are attracted round the two centres so formed. But numerous observations had satisfied the author that both spermatozoid and germinal vesicles are simply dissolved among the molecules of the yolk, from the substance of which, stimulated and modified by the mixture so occasioned, the embryo is formed; a view which has further the merit of explaining what is known of the qualities of both parents observable in the offspring. He was only acquainted with one exception to this general law, viz., the development of *Pyrozoma*, recently described by Mr Huxley, the description of which, however, was incomplete.* The truth appears to be, that in an analogous manner to that in which the pigment molecules of the skin are stimulated by the access of light to enter into certain vital combinations with one another, so are the molecules of the yolk stimulated by the access of the spermatozoid to produce those other vital combinations that result in a new being. The essential action is not so much connected, as has hitherto been supposed, with the cell wall or nucleus as with the molecular element of the ovum.

With regard to nutrition—food and all assimilable material must be reduced, in the first instance, to the molecular form, while the fluid from which the blood is prepared, viz. chyle, is essentially molecular. Most of the secretions originate in the effusion of a fluid into the gland follicle, which becomes molecular, and gives rise to cell formation. In muscle, the power of contractility is inherently associated with the ultimate molecules of which the fasciculus is composed; and lastly, the grey matter of the sensory ganglia, and of the brain, which furnishes the conditions necessary for the exercise of secretion, and of even intellect itself, is associated with layers of molecules which are unquestionably active in producing the various modifications of nervous force. These molecules are constant and permanent as an integral part of these tissues, as much as cells or fibres are essential parts of others, and their function is not transitory, but essential to the organs to which they belong.

All these facts point to the conclusion that vital action, so far

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* Annals of Natural History, Jan. 1860, p. 35.

from being exclusively seated in cells, is also intimately associated with the elementary molecules of the organism.

III. This leads me, in the third place, to an enunciation of the molecular law of growth, which a study of the numerous facts previously referred to has induced me to frame, viz.:—*That the development and growth of organic tissues is primarily owing to the successive formation of histogenetic and histolytic molecules.* We have already seen that development and growth in animals originate in the molecules of the yolk of the egg, or of a germinal molecular mass formed from it. The author referred to numerous careful researches recognised by scientific men as giving a correct account of the development of various animals and textures. From these it would appear that the first form was molecular; that the molecules united to produce nuclei and cells; that these became disintegrated to produce a secondary mass of molecules; that these again united to form secondary nuclei and cells; and that the same process was repeated more or less often in various developments, until the animal or tissue was formed. This constituted the successive histogenetic and histolytic molecules observable in the process of growth,—the former building up, to a certain extent, and the product disintegrating to produce the latter, which after a time, again, re-arranged itself and became histogenetic to form cells or tissues, which in their turn broke down and became histolytic. In short, not only development, but growth and secretion, absorption and excretion, were only different names given to histogenetic and histolytic processes, and that these were brought about by formative and disintegrative molecules. As illustrations of this law, the author minutely followed the development of *Ascarix mystax*, as described by Nelson,* and of the process of nutrition in the human body.

In this, and a vast number of similar observations, it must be evident that a certain series of molecular transformations is necessary for the one which follows it. Thereby is produced a continual elaboration of matter,—a constant chemical and morphological series of changes,—the exact number and order of which, in the production of organic forms, only requires time and perseverance to discover. Doubtless various conditions, dynamical, chemical, and vital, must co-operate in producing the result, and they must all influence mole-

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* Philosophical Transactions, 1850, plates xxviii., xxix., figs. 59, 68, 70, 78.

cular as well as every other kind of combination. Such considerations and facts must convince us of the error of endeavouring to place the source of special vital action in any particular form or arrangement of organic matter, whether fibre, cell, nucleus, or molecule. Each and all of these elements, the author contended, had their vital endowments, which re-operate on the others. But, inasmuch as the molecular element is the first as well as the last form which organised matter assumes, it must constitute the principal foundation of organisation itself.

The author pointed out that it was not his object, in directing attention to a molecular theory of organisation, to interfere in any way with the well-observed facts on which physiologists have based what has been called the Cell-theory of growth. True, this last will require modification, in so far as unknown processes of growth have been hypothetically ascribed to the direct metamorphosis of cell elements. But a cell once formed may produce other cells by buds, by division, or by proliferation, without a new act of generation, in the same manner that many plants and animals do, and this fact comprehends most of the admitted observations having reference to the cell doctrine. The molecular, therefore, is in no way opposed to a true cell theory of growth, but constitutes a wider generalisation and a broader basis for its operations. Neither does it give any countenance to the doctrines of equivocal or spontaneous generation. It is not a fortuitous concourse of molecules that can give rise to a plant or animal, but only such a molecular mass as descends from parents, and receives the appropriate stimulus to act in certain directions.

In conclusion, the author remarked that the theory he had endeavoured to establish on histological and physiological grounds, is fully supported by all the known facts of disease and of morbid growths, which further serve to show that pathology, so far from being cellular, is in truth molecular.

2. Notices of Early Scotch Planting. By Prof. Cosmo Innes.

The common opinion that Scotland was at one time closely wooded, is at least questionable, and some circumstances lead to an opposite belief: as,

The careful stipulations found in the most ancient deeds, about giving or withholding a limited use of wood for building and fuel.

The use of foreign timber for our greater buildings, when to be had; thus, Norway timber used for building the Abbey of Arbroath, in the 15th century.

The importation of bow-staves and spear-shafts, such long straight timber not being procurable at home.

The trees found in peat-mosses, for the most part small and few, and confined to narrow spaces, by no means prove a general covering of wood in ancient times.

One reason of the common error is the change of meaning which the word *forest* has undergone. From its etymology, the word has no connection with wood, and of old, and especially with old lawyers, it meant merely land privileged for the chase; but many people, meeting the word in old charters and descriptions of estates, suppose it to mean as at present, wood-land.

It is clear, however, that there has always been some wood, even timber, in Scotland.

The earliest Christian churches were of timber, probably in all countries; and the building of churches of stone was considered a novelty at the beginning of our acquaintance with church architecture in Scotland.

The forts built in inland lakes and morasses, which the Irish have taught us to call *cranogues*, of great antiquity, perhaps the most ancient extant dwellings except caves and burrows, are found often built on piles of oak of moderate size, and sometimes with beams of birch for the cross timber.

Sometimes beside these forts, but often apart, are found the shells of rude but large canoes, bespeaking a high antiquity, each hollowed out of a single oak.

Within the period of history (A.D. 1249), the Earl of St Pol and Blois, preparing for the Crusades, had a wonderful ship (*navis miranda*) built at Inverness.

The Bishop of Caithness, Chancellor of Scotland, and a friend of Edward the First, being engaged (A.D. 1291) in putting a roof on his cathedral of Dornoch, obtained from the king a grant of 40 oaks, fit for timber, to be taken out of the wood (*bosco*) of Darnaway, in Moray.

The Bishop of Brechin granting (A.D. 1435) a lease of the Kirkdavoch of Strachan for three lives, took the tenant bound to deliver, not periodically, but once only, oak laths enough for roofing

20 perches of the cathedral, or the Bishop's palace—*tantas vulgariter dictas lathis bonas et sufficientes de quercu.*

Two centuries later (1606), Alexander Davidson, styled tymberman in St Andrews, agrees with "the honest man that has bocht the wod of Drum, for als mekill tymber as will big ane bark." The timber was to be floated down the Dee, "how soon the water growis." This was evidently fir-timber. Nine trees were bought from the woodmen of Drum (1612–13) to make a sluice for one of the town of Aberdeen's mills, for the price of £27. These may have been oak.

The presumption seems very strong, from the present appearance of the ground, and all circumstances, that the timber in all these transactions was not planted, but of the native growth.

From all the evidence we have, old historical Scotland,—Scotland of the 14th to the 17th century, both included,—in regard to wood was very much as at present; making allowance, however, for the effect of cultivation which has curtailed it a little, and plantation, which has immensely increased its quantity in the last century. Speaking generally, the levels were cultivated, or bare moorland or swamp; the upland pastures, whether green or heathery, were bare of wood, except where the steep and rough glens, ravines, and water-courses, sheltered and protected from cattle a fringe of native wood—hazel, birch, or oak—the latter of small size. There are, and always have been, districts more or less willing to send up a native growth of timber—as Braemar; the upper part of Strathspey; the upper part of the valley of the Beauly; parts of Glenmoriston, and Loch Arkeg in Lochiel.

To remedy the defect of wood, some of our old codes of criminal practice appointed a form of procedure against trespassers and destroyers of wood; and the parliamentary records of Scotland are full of ordinances to encourage planting of wood, and even broom, in minute quantities; and for the repression of offences against it.

Following out the intention of the Legislature, the great proprietors had made some efforts at planting in the 15th century.

The Abbot of Cupar (A.D. 1473) set in lease the lands of Balmyle, in Strathmore, and bound the tenants to "put al the land to al possibil policie in biggin of housis, plantacioun of treis—*eschis*, *osaris*, and *sauch*, and froit-treis—gif thei ma."

From that time downwards, there are documentary proofs of some attention bestowed upon planting in Scotland; and, in a few, widely-scattered instances, we find places bearing marks of culture and planting that carry us back to that century; but all of these mark, also, that the effort was confined to the planting of a few trees near the mansion-house and the houses of the greater tenants.

In the next century (16th), but rather towards the end of it, considerable progress was made in the creation and embellishment of country houses. William, first Earl of Gowrie, who built a gallery, and decorated it with pictures, was a zealous planter, and was fond of the chestnut and walnut. In 1586, James, Lord Ogilvy, is found corresponding with Sir David Lindsay of Edzell, about their plantations, and writes to him—"Your thousand young birkis shall be richt welcom."

At the same period the Campbells of Glenurchy were creating the place of Balloch, now Taymouth, enforcing the planting of single trees amongst their tenants, and using vigorous measures for protecting wood. Probably similar operations were carried on in that century at Seaton, at Winton, Lethington, and other places; and some remains of still older cultivation are to be found about the seats of the old Church lords, as at Newbattle, Ancrum, Pinkie, and a few others.

It seems very doubtful whether any tree planted before the Reformation is now growing in Scotland. The date of the sycamore at Kippenross is not well vouched; and, to judge from appearance, neither it nor those at Newbattle can be ranked so old as 300 years. The chestnut at Finhaven was certainly much overrated when said in 1760 to be 500 years old.

Some ancient yews, especially the yew of Fortingall, come under a different category. It would appear that successive trees grow up in the bark and round the stem of the decayed yew, and may go on decaying and reproducing indefinitely.

About the period of King James's accession to the English throne (A.D. 1603) was the era of a great effort for improving and beautifying our country mansions, as shown in the Aberdeenshire castellated mansion, and others of the same taste all over Scotland. That period of fine taste was marked by great attention to planting, chiefly in the manner of avenues of ash and sycamore, with a timid intermixture of chestnut and walnut. During "the troubles" of Charles's reign and the Commonwealth, there was a cessation of progress;

but yet even in that time we find the Earl of Lauderdale sending to Taymouth for fir seed, and the Marchioness of Hamilton expressing her own interest, and that of several of her relations, in young firs grown from Breadalbane seed, and boasting that she had four or five hundred of her own planting. "Believe me," says she, "I think mair of them nor ye can imagin, for I loue them mair nor I dou al the froit-treis in the wordil." The Restoration (1660) brought a great change. Crowds of young men, virtually exiled during the Usurper's reign, then returned from wandering over the Continent, where they had learnt to admire the taste of the Italian villa and the French chateau. Evelyn tells us how universal the passion for rural embellishment and magnificent country houses was among the English nobility, and he himself helped to extend the public attention to restoring and planting wood.

Scotland kept pace as much as her poverty allowed. The botanical garden of Edinburgh was founded (1670). Country-seats were built or restored, and planting was carried on in many places where we can yet find trees to be ascribed to that period—still chiefly in the limited style of straight avenue and hedgerow. This was the date of a great enlargement—almost new modelling—of Taymouth, Hatton, Inverary, Drumlanrig, Hamilton, Hopetoun, Panmure, Kinross, Yester, Arniston, with a long *et cetera*.

The Revolution (1688) may be said to have renewed the impulse given by the Restoration. Again, a crowd of Scotch gentlemen whom the unhappy courses of the last Stuarts had driven abroad, returned to their own country, imbued with the taste of cultivation they had acquired in Holland and Flanders. Among these were Hume of Marchmont, the Dalrymples, Lord Haddington, Dundas of Arniston, Argyll, Hyndford, &c.

About this time a style of planting became fashionable, breaking a little from the formal straight avenue, and which was known as "the wilderness." The Earl of Mar at Alloa, his brother Lord Grange at Preston, Lord Haddington, and the First President Arniston, adopted this style; and at Arniston is preserved a plan of "the wilderness" as it was in 1726, which can still be distinctly traced on the lawn to the west of the house, and shows how little the original formality impedes the picturesqueness of the grown wood. There was a wilderness also at Blair-Atholl.

Lord Haddington remarks that planting was little understood in

Scotland till the beginning of the 18th century (1700), and, of planting in masses, the remark is nearly correct. He himself was among the first who planted on the great scale, and with method and discrimination. But a little before his time (A.D. 1680) Andrew Heron was planting at Bargally, in the stewartry of Kirkcudbright, which Loudon considered "the most interesting place in Scotland with respect to the introduction of foreign trees and shrubs." Dukes John and Archibald of Argyll followed, bringing their English experience to bear on Scotland. Lord Haddington and his wife made the noble wood of Tyninghame out of a rabbit-warren. The Earl of Bute, Lord Loudoun, and Lord Hyndford, were planters in the most favourable situations of Scotland. The Earl of Panmure planted endless beech avenues at Panmure, which within memory were grand and growing trees, and proved how the East Coast may be made to produce fine timber.

It has been said by old foresters that Panmure and Yester were the two places where beech was first planted largely. The taste spread rapidly. It was from Lord Tweeddale that the first President Dundas brought a present of thirty beech plants and one elm, which were carried in his portmanteau, on his servant's horse, to Arniston. The beeches are still standing and flourishing in the south avenue. They bear the marks of having been headed down in transplanting —a practice of that time.

Next came the taste for larch, which must have been introduced in several places as soon as at Dunkeld, though the story of the Duke's two flower-pot larches (A.D. 1727) may be true too.

A few giant larches at Arniston may be as old, and one or two in the "Paradise," by the river side at Monymusk, are apparently coeval, as they are coequal, with the finest trees at Dunkeld.

In the north country the Duchess of Gordon (the Mordaunt Duchess) was a great improver, and planted to some extent both at Gordon Castle and in Strathspey. Sir William Gordon of Invergordon planted and drained extensively; and other improvers and planters of that time were Ross of Balnagown, the Grants of Monymusk, Scott of Scotstarvet, Hope of Rankeillor, Lord Cathcart, Sir Francis Kinloch, Sir John Dalrymple, Wauchop of Edmonston, Sir James Dick of Priestfield, Sir James Stewart of Goodtrees, the Duchess of Buccleuch, Sir James Cunninghame, Lord Livingston.

Reid's "Scots Gardener," published in 1683, shows the taste for wood already begun. Sir Archibald Grant of Monymusk has left us a brief but interesting account of the planting and other improvements begun by him in 1716. The Earl of Haddington published, in 1733, a minute account of his planting operations. At Arniston are preserved original accounts and contemporary documents showing the extent and manner of planting there during almost the whole of last century, and also a narrative detailing the results made up from such materials, written by the Lord Chief Baron Dundas. An anonymous writer in 1729 (believed to be Mr M'Intosh of Borlum) mentions a good many improvers, enclosers, and planters, in Scotland at that time. Mr Walker, Professor of Natural History at Edinburgh, in his "Economical History of the Hebrides and Highlands," and his collected "Essays," gives the results of his own observations of trees through Scotland, from about 1760, for twenty years. Sang's "Planter's Calendar;" Dr Patrick Graham's "General Report of Scotland;" Monteith's "Forester's Guide;" Sir Thomas Dick Lauder's edition of "Gilpin," furnish a considerable mass of information of the state of wood in Scotland during a century past. And Loudon, in his most laborious and valuable "Arboretum et Fruticetum Britannicum," arranges and digests much of these materials. One important use served by the authors named is to enable us to compare the present condition and size of trees with what they were at ascertained distances of time previous; while the collection of returns of remarkable trees now making to the Highland Society, will serve as a foundation for such measurement and comparison in future times.

The following Gentlemen were admitted Ordinary Fellows:—

THOMAS HERBERT BARKER, M.D.
ROBERT MACLACHLAN, Esq.
JAMES YOUNG, Esq.

The following Gentleman was admitted an Honorary Fellow:—

Sir W. E. LOGAN, Director of the Geological Survey of Canada.

The following Donations to the Library were announced:—

Original Sanscrit Texts on the Origin and History of the People of India. By J. Muir, D.C.L. Part Third. 8vo, 1861.—*From the Author.*

Résumé Meteorologique de l'année 1859 pour Genève et le Grand Saint Bernard. Par E. Plantamour. 8vo.—*From the Author.*

Observation de l'Eclipse Totale de Soleil du 18 Juillet 1860. Par E. Plantamour.—*From the Author.*

Observations Astronomiques faites a l'Observatoire de Genève (1855-56). Par E. Plantamour. 4to.—*From the Author.*

Mesures Hypsometriques dans les Alpes. Par E. Plantamour. 4to.—*From the Author.*

Journal of Proceedings of Linnean Society, Vol. V. No. 19.—*From the Society.*

Almanaque Náutico para 1862. Cádiz, 1860. 8vo.—*From the Observatory of St Fernando.*

Monday, 15th April 1861.

The HON. LORD NEAVES, Vice-President, in the Chair.

The following Communications were read:—

1. Additional Observations on the Chronology of the Trap-Rocks of Scotland. By Archibald Geikie, Esq., F.G.S.

In a communication made to the Society last session, the author stated the results of a series of explorations among the trap-rocks of Scotland, and showed that, at successive periods, during the deposition of the Lower Silurian, Old Red Sandstone, Carboniferous, Oolitic, and Tertiary formations, there were contemporaneous eruptions of volcanic material. During the year 1860, the investigation was continued across the Highlands into the Inner Hebrides, and throughout a large part of the central counties southward to the Cheviot Hills. The author was now able to fill in more fully what had only been sketched in outline in the previous paper, and to prepare a series of maps to illustrate the volcanic areas of Scotland during the successive geological periods. He showed that, in the Scottish Highlands, no distinct trace existed of any igneous rock erupted contemporaneously with the deposition of those Lower Silurian strata which are now metamorphosed into gneiss, mica-schist, clay-slate, &c. The greater part of his observations during the past year had been devoted to the elucidation of the chronology of the igneous rocks belonging to the period of the Old Red Sandstone, and he found that, in central Scotland, that formation exhibited a copious series of contemporaneous felstones and ash-beds in its lower and upper members; the former being exemplified in Forfarshire and Perthshire, and the latter in Fife and in the Pentland Hills. Several additional facts had also been observed among the Carboniferous trap-rocks, tending to make the series more complete, and to show how with volcanic movements there were associated certain risings and sinkings of the land, whereby the fauna and flora of the Carboniferous period were locally modified. Reference was also made to the remarkable series of greenstone and basalt dykes which traverse Scotland from N.W. to S.E., and enter the northern English counties. From observations made at either end of the series, the author deduced the inference that these dykes are later than the Lias, and probably belong to the period of the Middle or Upper Oolite.

2. Notes on Ancient Glaciers made during a brief Visit to Chamouni and its neighbourhood in September 1860. By David Milne-Home, Esq. of Wedderburn.

With reference to the *Mer de Glace*, the author described the great transported blocks on the slope of the hill above Montanvert Inn; the smoothed rocks about 250 to 300 feet above the glacier; the two ancient lateral moraines on the east side of the valley; the action of the ice on a perpendicular wall of rock near foot of glacier; the old moraine of Lisboli, which must have formerly crossed and blocked up the valley, and the transported blocks on the hill of Flegère, about 2700 feet above Chamouni, and probably deposited there by glacier, when it was at the level of the blocks above the Montanvert.

The hill of Chavant was next described, situated about six miles west of Chamouni, on the north side of the valley, the south slopes of which are beautifully smoothed and scratched to the top of the hill, which is 1000 feet high. The scratches in some places inclined at an angle of 15° to 20°; their direction near foot of hill, W.N.W.; about midway up, N.W.; and near top N.N.W. by compass.

On west side of valley, opposite to Chavant, at the Hameau of Le Grange, there are rocks of soft schist, flattened, smoothed, furrowed, and scratched. In several places there are veins of hard quartz standing three or four inches above the general surface of the smoothed rocks, on the south side of which veins the furrows generally stop, as if the furrowing agent had been obstructed by them. A model illustrating the phenomenon was exhibited. The direction of the furrows and scratches is here due N. and S. The locality is 1300 feet above Chamouni, and 4725 feet above the sea.

It was mentioned that transported alpine blocks occur on both sides of the valley here, and all the way down to the Petit Salève mountain (near Geneva), distant about thirty miles, the S.E. slope of which faces the Arve valley. These blocks cover the hill to its top, which is 2800 feet above the sea.

The author mentioned having visited the glaciers in the higher parts of Chamouni valley, and that he had satisfied himself of the fact that an ancient glacier had passed northwards into the Val Orsine. He considered that the whole of the upper part of Chamouni valley had been filled with ice, which had flowed, not down that valley, but through the Val Orsine. The pass into this valley must at that time have been at least 1000 feet lower than the obstruction across the valley of Chamouni caused by the Mer de Glace.

Some account was then given of the marks of ancient glaciers in the valley of the Rhone; and attention was more particularly drawn to the enormous deposits of gravel, sand, and clay throughout low Switzerland, and to the important fact, that the great transported blocks on the Jura, and elsewhere in low Switzerland, are generally imbedded in these pleistocene strata.

It was also mentioned that the transported blocks are at greater absolute heights near the mouth of the valley of the Rhone than anywhere else; and that these heights, both for the blocks and for the gravel and clay beds, diminish gradually towards the west. The sloping line of the latter along the south bank of Lake Leman is a striking object from Lausanne.

The author expressed his conviction, from the phenomena referred to, that glaciers had formerly descended to the low country through the valleys of the Arve and Rhone, bringing down and spreading in all quarters blocks and detritus. The only difficulty felt was as to the cause of the low temperature necessary to produce glaciers on so great a scale.

He was inclined to the opinion, that at the time of this low temperature, the whole of Switzerland had stood 3000 feet higher above the sea than at present; the effect of which would be to produce at Geneva a temperature equal to that now prevalent at the places where the alpine glaciers melt.

In support of this view, he referred to the upheavals and depressions of this part of Europe, before and after the transportation of the blocks. The former is established by the dislocation and slope of the beds of *molasse*, a deposit which immediately underlies the gravels and blocks of the great glacial period. The latter is established by the stratification of the glacial detritus into regular beds, mostly horizontal, and in very many instances enveloping transported blocks.

His notion of the sequence of events was therefore as follows:—

1*st*, Switzerland elevated 3000 feet higher than at present; at which time the molasse beds were fractured and thrown into steep slopes. The temperature of low Switzerland would then be low enough to allow the glaciers to descend as far as the Jura; and the whole country would then be overspread with glacial detritus.

2*d*, A submergence of Switzerland under the sea, to the extent of 3000 or 4000 feet lower than the existing levels, followed, when the glacial detritus would be arranged into horizontal beds of gravel, sand, and clay.

3*d*, A re-elevation of the country to the present levels took place, since which event, the pleistocene strata in the valleys have been scoured out by the action of the rivers.

Monday, 29th April 1861.

PROFESSOR ANDERSON, in the Chair.

The following Communications were read:—

1. On the Aqueous Origin of Granite. By Alexander Bryson, P.R.S.S.A.

In this paper the author referred to the labours of Dr William Smith, who published his "Tabular View of the British Strata" in 1790, and remarked that since that period geology had been studied mainly in the direction of Palæontology. Physical, chemical, and dynamic geology, were left almost unregarded by the great masters of the science, who generally accepted the speculations of Hutton and the experiments of Hall, as demonstrating the igneous origin of the primary rocks.

The author stated that the Huttonian theory was most ably attacked, and, in his opinion, overthrown by Dr Murray in his "Comparative View of the Huttonian and Neptunian Systems of Geology," a work most unaccountably overlooked. Since that time it had suggested itself to the sagacious mind of Davy, that the occurrence of fluids in the cavities of crystals seemed to point to an aqueous origin. He also alluded to the writings of Brewster, Sivewright, and Nicol, in the same field; also to Becquerel, Fuchs, Bischoff, and Delesse, who have taken up the subject of the aqueous origin of rocks from a chemical point of view. The author then laid before the Society the result of ten years' experimental investigation into the structure of rocks relative to their formation, more particularly granite. While examining microscopically the various pitchstone veins abounding in Arran, he was much struck with the similarity of their structure, and the marked difference they exhibited when compared with sections of granite and its various mineral constituents. On extending his observations to obsidian, marekanite (a volcanic glass from Lake Marekan in Kamtschatka), and also to the well-known glassy obsidian of Bohemia, he found they all exhibited a structure analagous to the pitchstones of Arran. He further found that sections of glass slags, where the heat had been long continued, combined with slow cooling, all presented the same appearances as the sections of pitchstone.

This structure, peculiar to igneously formed substances, he found usually to radiate in a stellate form; and though many slags showed large stars visible to the naked eye, the stellate structure is more easily observed by the aid of the microscope. The character is so marked that no one whose eye is tutored to microscopic observation can fail to recognise at once a mineral substance of igneous origin.

In granite, on the other hand, the structure, as seen by the microscope, is as persistent as in pitchstone, glass, and obsidian, but totally different.

In the many experiments which the author had tried with granites from various localities, he had never succeeded in obtaining one instance of stellate structure, while the constant occurrence of cavities containing fluids convinced him that, if pitchstone and glass are types of igneous-formed substances, granite must be of aqueous origin. In the fluid cavities so abundant in topaz, Cairngorum, beryl, tourmaline, and felspar, all constituents of granite, he found the same appearance prevailed. These cavities are seldom entirely filled with fluid, an air-bubble usually occupying more or less of the cavity. After many hundred experiments on such cavities, the author found that when exposed to a temperature of 94° Fahr., the bubble disappeared, the fluid entirely filling the cavity, and at the temperature of 84° the bubble reappeared with a singular ebullition, showing that the air had formed an atmosphere round the fluid. He was thus led to infer that those cavities could not have been filled at a temperature above 84°, and certainly not above 94° of Fahrenheit.

As another proof that these cavities could not have been filled when the temperature of the surrounding rock was higher than the temperature above indicated, the author drew attention tó the fact, that the bubble of air occupied always a much smaller portion of the cavity than the fluid, a condition which could not obtain, if, as other writers hold, the fluids were enclosed under intense heat and pressure.

For the purpose of accurately determining the temperatures at which the bubble vanished and reappeared, the author constructed an apparatus which he exhibited and described. It consists of a microscope with a hollow iron stage, having a tube in the centre to admit light from the reflector. At one side, and inserted into the stage, is a small tin retort with a stopper; at the other side, a tube is inserted and attached to a reservoir of water, from which the hollow stage and retort are filled. On applying heat to the retort, by means of a spirit-lamp, any required temperature under the boiling-point of the water may be obtained in the stage and retort.

Above the stage is placed an iron saucer, in the centre of which an iron tube is rivetted, through which the light is admitted; this vessel is filled with mercury, and in it is placed an upright thermometer, with the bulb shielded with cork or any other good non-conductor; by this means it indicates the actual temperature of the mercury bath. The cavity to be observed is cemented with Canada balsam to a plate of glass 3 × 1 inch, and is floated on the surface of the mercury, so that the glass and mercury are in absolute contact. When the temperature is raised until the bubble nearly disappears (which is seen by its contraction), the spirit-lamp is withdrawn, and the vanishing point carefully watched, and the temperature noted. The stopper of the retort is then withdrawn, and the stop-cock of the reservoir of water opened, so that the temperature of the stage and mercury bath is soon reduced, and the ebullition or reappearance of the bubble takes place, when the temperature is again recorded. By this method the author felt confident that his results were correct, as they always were consistent when observing the same cavity. By means of this instrument the author had found fluid cavities in the trap tuffa of Arthur's Seat, the greenstone of the Crags, and the basalt of Samson's Ribs. He had also found that the porphyry of Dun Dhu in Arran, which most geologists assumed as of igneous origin, was full of fluid cavities contained in the doubly acuminated crystals of quartz for which this remarkable porphyry is distinguished. He also showed doubly acuminated crystals of quartz in the saliferous gypsums of India, both of which were full of fluid cavities, and the quartz impressed with the gypsum ; and as no geologist would hold that this formation was of igneous origin, but that the quartz, if not contemporaneous with the gypsum, must have been subsequent, and as the same phenomena were presented by the porphyry of Dun Dhu, he was forced to the conclusion that it was as much aqueous in its origin as the saliferous gypsum of India. The author exhibited a specimen of quartz which contained a crystal of iron pyrites, to which was attached a crystal of galena and also a small massy zinc blende, while over these three metals was laid a covering of gold. From this specimen he argued, that as all these metals were fusible at a much lower temperature than quartz, they must have aggregated during a gelatinous condition of the quartz ; and further, that as the sulphides of the three metals were in chemically combining proportions, any heat which would have fused the quartz would have made an alloy or a slag in which chemical combining proportions could not occur.

He also exhibited specimens of schorl which he had obtained in the granite of Aberdeen, and drew the inference that schorl, which crackles and splits with a very small increment of temperature, could not have been present during a molten condition of the quartz ; and that it was crystallized prior to the solidifying of the latter, as proved by the schorl impressing the quartz. The author, from a careful examination of the schorls in the quartzite of Aberdeen, was led to believe that the quartz, while in the process of crystallization, expanded one twenty-fourth of its bulk, a force which appeared to him to be sufficient to cause all the upheavals and disruptions which had led geologists to account for such phenomena by a molten condition of the primary rocks. If this view is correct, and if the highest peak is granite, as the lowest is known to be granite, the author calculated that as the highest mountain is only $\frac{1}{571}$ part of the radius of the earth, a thickness of the crust of 168 miles is quite sufficient to yield expansive force to raise the highest peak of the Himalayan range. He further stated that the cause of the temperature at which the fluids were confined being higher than the normal one, depended on the rise of temperature which takes place during solidification.

The author, in conclusion, trusted he would soon be in a position to confirm these views when he had finished the investigation of the trap rocks with which he is now engaged.

2. Notes of Excursions to the Higher Ranges of the Anamalai Hills, South India, in 1858 and 1859. By Hugh Cleghorn, M.D., F.L.S., Conservator of Forests, Madras Presidency.

The southern ranges of the Anamalai (*i.e.*, Elephant) Hills having been little explored, and only known through the manuscript report of Captain J. Michael, 39th N.I., formerly of the Forest Department, the author was induced to project an excursion to these heights, in concert with Dr D. Macpherson, Inspector-General of Hospitals, and the Collector and Engineer of the Coimbatore District (Messrs Cherry and Fraser). The arrangements were made under the auspices of the Right Hon. Lord Harris, Governor of Madras, and His Excellency Sir P. Grant, complied with the request that Major Douglas Hamilton, 21st N.I., should accompany them as artist, to delineate the characteristic features of the country. (This officer's sketches, seventeen in number, some of them panoramic, were exhibited. A selection will appear in the Transactions). Notwithstanding the unfavourable state of the weather, the result was not without interest, much additional information having been obtained, which elucidates Col. Fred. C. Cotton's narrative of an expedition over the Anamalai mountains (northern range). (See "Madras Journal of Literature and Science," vol. ii. p. 80. 1857.)

The main results of the excursion were extracted from his Diary, beginning 15th Sept. 1858. "Teak occurred on some undulating knolls, two or three miles before reaching the village (Punáchi), and on the slopes of the basin leading to the river (Torakadu). The teak tree is not of superior dimensions, but is thickly scattered, forming nearly half of the forest. Many of the trees would yield second-class logs, and they increased in size as we descended the gorge. Being in flower, the white cross-armed panicles formed a striking feature in the landscape. There was much fallen and decaying teak within three miles of our huts. I inspected the jungle both in going and returning, and walked across in different directions to estimate approximately the number and size of the trees, and came to the conclusion that the value of standing wood might be 50,000 rupees, and of fallen timber at least 5000 rupees, a sum which could easily be realised, if there had been easy transport. We saw, farther up the valley, much Vengé (*Pterocarpus marsupium*) and blackwood, which became more abundant, as the elevation increased. These trees seem to prefer an altitude somewhat greater than teak, whilst the Vella Nága (*Conocarpus latifolius*), of great size, occurs with the teak, or prefers a lower range. The sholas (glades) near Punáchi, between 3000 and 4000 feet above the sea, are very dense and rich in their flora. The following are a few remarkable forms observed, a new species of *Jenkinsia* (Wallich), *Solenocarpus Indicus*, a tree called by the Kaders Palli-illi, the leaves of which are eaten. *Elæocarpus Monoceros*, a new species of *Cookia* (Mur Kuringi), with a delicious fruit. *Glycosmis pentaphylla*, *Pierardia macrostachys*, with an edible fruit. *Cleidion Javanicum* (Wall); *Mesua*, with very large fruit; *Calophyllum*, a species with narrow lanceolate leaves; *Orophea*, two new species; *Unona pannosa*, *Guatteria coffeoides*, *Cyathocalyx zeylanicus*; *Garcinia*, *Pterospermum obtusifolium*, *Sterculia guttata*, *Machilus*, *Casearia*, a new species; *Euonymus*, two apparently new forms, one with downy leaves, and the other much like a lime tree. *Agrostemma*, two species, *Ophioxylon*, a new species, with falcate bracts; and *Othomorphe subpeltata*. *Acranthera zeylanica*, *Nephelium erectum*, a very gorgeous species of *Pachycentria*, and two rare Euphorbiaceous trees, *Dimorphocalyx glabellus*, and *Desmostemon zeylanicum*, lately described by Mr Thwaites.

" Many of the trees in the dark sholas are covered with beautiful epiphytes, especially the *Hoya pauciflora*, *Æschynanthus zeylanicus*, and *Sarcanthus filiformis*. The dripping rocks are adorned with *Klugia* (two species), *Epithema*, &c. Cardamoms with rich aroma, and the true ginger plant, abound in these sholas. The rocks in the bed of all the rivers, from 3000 to 4500 feet, are quite covered with a showy orange-coloured Balsam (*Impatiens verticillata*). It often forms a fringe at the line of watermark, or appears in patches between the forks of a cascade. At a higher elevation, other species seemed to take its place, especially the "*Impatiens Tangachee*" (Beddome). A truly aquatic fern, a new species of *Pleopeltis*, grows in great abundance on rocks at the bottom of the Torakadu river.

"The *Rhododendron arboreum* was first seen at an elevation of about 5000 feet."

Mr Beddome has favoured me with the following note of his ascent:—"The rocky Akka Mountain, which is probably upwards of 8000 feet, is quite covered near its summit with several new species of *Impatiens*. The only other new form observed on this mountain was a curious Crassulaceous plant with fleshy peltate leaves, growing in sheltered moist nooks of the rock. Balsams are very abundant on these hills. *Impatiens Balsamina*, *dasysperma*, *Hensloviana*, *maculata*, *Campanula*, *chinensis*, *tomentosa*, *verticillata*, *oppositifolia*, *Kleinii*, *filiformis*, *tenella*, and *rivalis*."

"Some of the herbaceous plants observed adorning the higher hill-side pastures were:—*Flemingia procumbens*, *Phaseolus Pulniensis*, *Anemone Wightiana*, *Lysimachia Leschenaultii* and *deltoidea*, *Utricularia*, *Ranunculus reniformis*, *Gentiana pedicellata*. This list might be extended, but the examples are sufficient to show the similarity of the Flora to that round Utakamand."

The general appearance and character of these high lands resemble much the Nilgiri Hills. Here are the same rounded eminences and dense sholas, extending continuously for miles, their edges fringed with *Strobilanthes*, and ceasing abruptly; the hills are conical, and the slopes covered with short, rich grass, abounding with such plants as *Exacum bicolor*, and *Ophelia elegans*: the woods contain *Hymenodyction excelsum*, and other species of the Cinchona family. Heavy rains, evidently the breaking up of the south-west monsoon, fell continuously during the period of our stay in these upper regions. The want of shelter, and the difficulty of procuring supplies, prevented us from proceeding to the highest parts of the range, which appeared to be about twelve miles in a south-east direction from the extreme point the party reached. We therefore reluctantly returned to the low country without fully attaining our object, having been absent eight days. Three distinct tribes inhabit the Anamalai hills ; they are denominated Kâders, Paliars, and Malsars. The Kâders perform no menial labour; as their name implies, they are the lords of the hills; they will carry a gun, and loads also as a favour, and are expert at stalking game, but are deeply offended if they are called coolies. They are a truthful, trustworthy, and obliging tribe, and exercise some influence over the Paliars and Malsars. Small in stature, their features resemble the African ; they have curly hair tied in a knot behind, and file the four front teeth of the upper jaw to a point, as a marriage ceremony. The upper ranges are in undisturbed possession of wild beasts ; we saw a large herd of bison, with samber and ibex in numbers, and also traces of wild elephants.

The soil on the summit of these fine mountains is deep, and covered with good pasture. Streams of water are numerous, and flow throughout the year. From the extent of forest, the resemblance of the Flora to that of Ceylon and the corresponding altitude, these hills seem suitable for the cultivation of coffee on a large scale, and for colonisation of small communities of Englishmen.

3. On the Contractions suffered by Sulphuric Acid on being mixed with Water. By Dr Lyon Playfair, C.B.

4. On the Constitution of Anthracene or Paranaphthaline, and some of its Products of Decomposition. By Professor Anderson.

The following Gentleman was elected a Fellow of the Society :—

Alex. E. Mackay, M.D., R.N.

The following Donations to the Library were announced:—

Quarterly Report of the Meteorological Society of Scotland for the Quarter ending 30th December 1860.—*From the Society.*

The Canadian Journal—March 1861.—*From the Canadian Institute.*

Report of the Yorkshire Philosophical Society—1860.—*From the Society.*

Transactions of the Royal Irish Academy. Vol. XXIV., Part 1. 1860.—*From the Society.*

Bulletin de la Société de Geographie. 4^{me} Serie. Vol. XX. 1860.—*From the Society.*

Silliman's American Journal of Science and Arts. March 1861.—*From the Editors.*

Atti dell Imp. Reg. Istituto Veneto. Vols. V. Parts 6–10; VI. Parts 1–3.—*From the Institute.*

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Wien, 1860. 8vo. Math.-Natur. Classe, B. XLI., Nos. 13–21; XLII., 22–26. Phil.-Hist. Classe, B. XXXIV., No. 2; XXXV., Nos. 1, 2.—*From the Academy.*

Archiv f. Kunde Osterreichischer Geschichts-Quellen. B. XXIV., Part 2.

Mémoires de l'Académie des Sciences. Tome XXVIII. Paris, 1860. 4to.—*From the Institute.*

Abhandlungen der K. Bayerischen Akademie der Wissenschaften. Math.-Phys. Classe, B. VIII., Part 3. Philos.-Philol. Classe, B. IX., Part 1. Historischen Classe, B. VIII., Part 3.—*From the Bavarian Academy.*

Gelehrte Anzeigen, B. XLIX. and L.—*From the same.*

Glossarium op Maerlants Rymbybel, door J. David. Brussel, 1861. 8vo.—*From the Royal Academy of Belgium.*

Alexander's Geesten, van J. van Maerlant. Brussel, 1860. 8vo.—*From the same.*

Memoires Couronnés de l'Académie Royale des Belgique. Tome X., 1860. 8vo.—*From the same.*

Bulletin de l'Académie Royale de Belgique. 2^{me} Sér. T. IX. and X. 1860. 8vo.—*From the same.*

Annuaire de l'Observatoire Royale de Bruxelles. Par A. Quetelet. 1861.—*From the same.*

Annuaire de l'Académie Royale de Belgique, 1861.—*From the same.*

Mémoires de l'Académie Royale de Belgique. T. XXXII. 1861. 4to.—*From the same.*

Phénomènes Periodiques. Par A. Quetelet. 8vo.—*From the Author.*

Sur la Physique du Globe. Par A. Quetelet. 8vo.—*From the same.*

Observations des Phénomènes Périodiques. Par M. A. Quetelet. 4to.—*From the same.*

Sur le Congriès international de Statistique. Par Ad. Quetelet.—*From the Author.*

Proceedings of the Academy of Natural Sciences of Philadelphia, pp. 285-579.—*From the Academy.*

Journal of the Academy of Natural Sciences of Philadelphia. New Series. Vol. IV., Part 4. 1860.—*From the same.*

Observations on the Genus Unio. By Isaac Lea, LL.D. Vol. III., Part 1.—*From the Author.*

Smithsonian Contributions to Knowledge. Vol. XI. 1859.—*From the Smithsonian Institution.*

Proceedings of American Association for Advancement of Science. 1859.—*From the Association.*

Ohio Agricultural Report, 1858. 8vo.—*From the Ohio Board of Agriculture.*

Memoirs of American Academy of Arts and Sciences. New Series. Vol. VII. 1860.—*From the Academy.*

Transactions of American Philosophical Society. Vol. XI., Part 3. Philadelphia, 1860.—*From the Society.*

Proceedings of American Philosophical Society. Vol. VII., No. 63. 8vo.—*From the same.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. IV. 1861–62. No. 56.

SEVENTY-NINTH SESSION.

Monday, 25th November 1861.

Dr CHRISTISON, V.P., in the Chair.

The following Council were elected:—

President.

HIS GRACE THE DUKE OF ARGYLL, K.T.

Vice-Presidents.

Sir DAVID BREWSTER, K.H.
Dr CHRISTISON.
Professor KELLAND.
Hon. LORD NEAVES.
The Very Rev. Dean RAMSAY.
Principal FORBES.

General Secretary,—Dr JOHN HUTTON BALFOUR.

Secretaries to the Ordinary Meetings,—Dr PLAYFAIR, Dr ALLMAN.

Treasurer,—J. T. GIBSON-CRAIG, Esq.

Curator of Library and Museum,—Dr DOUGLAS MACLAGAN.

Councillors.

Dr LOWE.
Professor W. J. M. RANKINE.
JAMES DALMAHOY, Esq.
Dr JOHN BROWN.
Professor FRASER.
JAMES LESLIE, Esq., C.E.
Dr SCHMITZ.
Dr SELLER.
E. W. DALLAS, Esq.
Rev. L. S. ORDE.
Professor TAIT.
JOHN MUIR, Esq., D.C.L.

Monday, 2d *December* 1861.

The Very Reverend Dean Ramsay, one of the Vice-Presidents, delivered the following Opening Address:—

It is with no affectation of humility, it is with no mock modesty that I earnestly bespeak your kind indulgence for the discharge of the duty to which I have been called this evening. My diffidence in this matter arises from no want of interest in the work assigned to me, but from knowing how much I lack that extent of knowledge and that degree of experience which seem to be required for the position in which I am placed, and for such an audience as I have the honour to address. I find different scientific associations adopt different rules. In some cases the secretary makes, in name of the council, a general report of the whole proceedings during the past year; in fact, very much in the business style of the secretary of a railway company. In some cases, the address is delivered on the anniversary of the society by the president, who makes a distribution of its medals and prizes previous to his vacating his office.

The Royal Society of Edinburgh has only of late years adopted the practice of an address from the chair on the first meeting of the Session, with notices of the deceased members during the year; the medals and prizes being distributed usually towards the end of the Session. The address on the first meeting of last Session was delivered by our recently elected President, the Duke of Argyll; and it was well observed on that occasion, I think by Lord Neaves, that the address itself was the best proof of the Society having chosen their President well and wisely.

As to the statistics of the Society, I may mention that eight members have died during the past year:—

Rt. Hon. The Earl of Aberdeen.
Robert Bell, Esq.
Rt. Hon. Lord Campbell.
John Gordon, Esq., of Cairnbulg.
Professor More.
Sir James M. Riddell, Bart.
The Rev. Dr James Robertson.
E. D. Sandford, Esq.

Sixteen new members were elected during the past year:—

W. A. F. Browne, Esq.
The Rev. Thomas Brown.
R. E. Scoresby-Jackson, M.D.
James M'Bain, M.D., R.N.
Professor P. Guthrie Tait.
John Muir, D.C.L.
William Turner, M.B.
W. L. Lindsay, M.D., F.L.S.
James Lor er, Esq.
Archd. Geikie, Esq., F G.S.
William Handyside, Esq.
George Berry, Esq.
Thos. Herbert Barker, M.D.
Robert Maclachlan, Esq.
James Young, Esq.
A. E. Mackay, M.D., R.N.

Three members resigned during last year:—

Andrew Murray, Esq.
Brinsley de Courcy Nixon, Esq.
Horatio Ross, Esq.

Total Number of Fellows for 1860, ... 253
„ „ 1861, including a member not inserted in last list, ... 259

In glancing backwards on the *proceedings* of the last year, it is quite manifest that there has been no falling off in zeal and diligence amongst its members. Besides other business in connection with the objects for which the Society was embodied, thirty-three papers were read at the ordinary meetings. Seven were on subjects connected with Geology; nine with Natural History or Physics; seven with Chemistry and Chemical Analyses; four with Magnetism or Electricity; the rest were of a miscellaneous or biographical character. Without noting particular papers, it is quite enough to say of these communications that they are the result of deep study and careful experiment; that they are fully in accordance with the high and advanced state of the several sciences to which each of them belongs. The only regret I have (a regret which I cannot help expressing) is, that we have not more papers of a literary character. Such papers would be quite in accordance with the original purpose and object of the Society. They would make a pleasing variety, I believe we might almost say a *relaxation* of attention towards the subjects with which our evenings are generally occupied, and (perhaps this is my chief recommendation) they would call forth contributions from some of our members who have not given themselves to the study of physical sciences, but whose present inaction, session after session, we cannot but deplore. We regret to think that we have not occasionally papers on such questions as Moral Philosophy, Political Economy, History, Classics, or Belles-Lettres, from Fellows of the Society, who, we are sure, could execute them so ably and so gracefully. The productions of the last Session, and the attendance at the evening meetings, indicate, then, a continued activity and interest in the cause of science. And we notice this fact as supplying the answer to an objection which we have heard raised against the Royal Society of Edinburgh, and against other associations of the same character, viz., that their day had gone by; that they were well suited to a period when there was little or no scientific current literature, but that their place has been superseded by periodicals—that is, by scientific magazines and journals, to which men of science will now prefer sending their papers, rather than to the less popular and less known Transactions of societies. Experience has proved the objection altogether fallacious. Societies have done for science and literature what could have been accomplished in no other way. There is the advantage of personal intercourse at their meetings, whether ordinary or extraordinary,—of funds for prizes,—of libraries, and of the general prestige of men of high place and high reputation being associated in bodies under sanction of Royal patronage. The Transactions of home and foreign societies would themselves form a scientific library of considerable extent. The library of the Royal Society of London now exceeds 40,000 volumes, chiefly on scientific subjects, and in mathematical works is surpassingly rich. At no time were such associations, either in this country or the continent of Europe, more active and more efficient. No doubt this very activity and efficiency have produced a change, which, to a certain extent, *must* affect the old scientific institutions. The change to which I refer is due not only to the great increase of the *number* of such institutions, but to the great subdivision of the labour in scientific inquiries. The Royal Society of London was founded in 1663. Its general object was the promotion of Science and Literature. The vast number of illustrious names connected with that great Society, and the extent of research manifested in its Transactions, amounting to 200 volumes, are well known to all whom I address. Other similar institutions were formed in London in subsequent years. The Royal Society of Edinburgh followed, and many provincial associations throughout England. Of these the Literary and Philosophical Society of Manchester, instituted 1781, has been long distinguished. Dr Percival was one of its early supporters. His papers, and communications from Mr Dalton, Dr Henry, and others, have ever been had in high esteem. At Liverpool, Bristol, York, Bath, Leeds, Exeter, and other places, large sums of money have been expended in buildings for the meetings, museums, libraries, lecture-rooms of similar societies, and were called forth to meet the growing taste for scientific study, and the vast increase of persons in all professions and ranks of life who delighted in natural history, physical science, and the study of history, of literature, and philosophy. We now find the operations of our learned societies becoming associated with our social system itself.

The *history* of the Royal Society of London becomes an important work, and is, in fact, a history of science itself during the period when the Society was in action.*

In reference to the history of scientific institutions, we can scarcely omit to notice the endeavours that have been made to draw the members closer together in social as well as scientific relations—such as dinners, holding *conversazione* meetings, and other friendly unions. I hope it will not be considered unbecoming in this address to mark how completely the *scientific* association is adapting itself to the *social* system, and becoming part and parcel of common life. It is from this circumstance, I apprehend, that a certain part of the history of the Royal Society of London has lately excited so much attention. An account of it has been printed for private circulation by Admiral Smyth, to whom the necessary documents connected with it were intrusted. I mean its *Dining Club*. The annals of its proceedings commence in 1743; but Admiral Smyth, and others, zealous in all branches of archæology, are persuaded that the club dates much further back. The club was at first called the "Royal Philosophers;" and although the archives of the Royal Society are unfortunately deficient on many points of its proceedings, they are very minute in their account of the dinners of the Royal Philosophers. Thus we have the satisfaction of knowing the precise dinner to which the Royal Philosophers sat down, 27th October 1743—a dinner, let it be remembered, eaten at one o'clock, and a pretty solid one:—

Turkey boiled and oysters.
Calves head hashed.
Fowls and bacon.
Chine of mutton.
Apple-pie.
Two dishes of herring.
Tongue and udder.
Leg of pork and peas.
Sirloin of beef.
Plum-pudding.

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* History of the Royal Society of London, by Birch.

The dining club is now generally adapted as a concomitant of the learned association, and with very pleasant results. But the Royal Society of London were so desirous to consider their dinners part and parcel of the *Society* itself, that it was one of their early rules to fine any member a guinea who called it a club.

The Astronomical Society have long had a dining club in conjunction with their scientific meetings. From what connection or analogy with sidereal investigation I do not know, but one invariable dish at the astronomical dinners is black pudding.

The dining club of the Royal Society of London has evidently, then, been considered a very important appendage; indeed, Admiral Smyth remarks: "The hospitality of the Royal Society Club has been of *material utility* to the well-working of the machine." "This is proved," he goes on to state, "by the number of men of note, both in ability and station, who have there congregated previously to repairing to the evening meeting of the body at large; and many a qualified person, who went thither a guest, has returned a candidate." It has been a sound policy, therefore, as Admiral Smyth conceives, which so early in the history of the Royal Society dictated the formation of a dining club in connection with the more scientific portion of the body. It introduced a bond of unity of a different character from the scientific bond. Dr Johnson and other learned men have attached great importance to their dinner, and were not in humour for pursuing literary thoughts where it was wanting or where it was bad. When the discussions were going on about the propriety of having a cook attached to the French Institute, an eminent Paris judge told La Place, as a reason for having a cook, that he considered the discovery of a new dish far more important than the discovery of a new planet, and added this reason for the opinion: We have already quite enough of planets, but we can never have too many good dishes.

It soon became evident, as years rolled on, that a greater subdivision of scientific labour must follow upon the older societies, formed as they were for general scientific purposes. Enthusiastic cultivators of particular branches of science wanted something more exclusive. The first actual movement in this direction was, I believe, the Linnean Society, founded in 1788 for promoting the study of zoology and botany, as these sciences had been organised and advanced by the immortal naturalist whose name gave the character to the association.

This society had a further division in its Botanical Section promoted by such men as Brown, Lindley, and Hooker, whose object was to pursue, unfettered by the artificial classification of Linnæus, the natural system of Jussieu as a more philosophical system, and already vigorously pursued on the continent by the elder Decandolle and other great botanists. Societies formed for promoting special objects in science and natural history sprung up in every quarter. Thus, we have the Antiquarian Society, the Royal Astronomical Society, the Geographical Society, Geological Society, Entomological Society, the Horticultural Society, the Meteorological Society; and to show the extended character of these subdivisions, I may mention the Royal United Service Institution, exclusively devoted to questions connected with warfare, whether by sea or land. Few persons unconnected with the naval and military professions are aware of its precise object and character, or of the extent of its operations. It is termed the "Royal United Service Institution," because it has a Royal charter. It is in regard to machinery very much like our own.* It has vice-presidents, a library, museum, meetings, and proceedings; papers are read, and transactions published, and the subjects of those papers are all strictly bearing upon military and naval service. To show the character of the topics chosen for these papers, I will read over a few of those already published in their Transactions, many of which, I have been told, are exceedingly able, and admirably illustrated by models, maps, and drawings. For instance, the whole of the number for August is occupied with a dissertation on Iron-Cased Ships, by Captain Halsted, R.N. June number contains a paper on Photography and its Application to Military purposes; another on the Military Forces of the Nations of Europe; one upon Swiss Targets and Rifle Ranges. There is a paper in a late number on National Defence, called the Rifle and the Rampart; one upon the Sanitary Condition of the Army; one upon Recreations for Soldiers and Sailors; one upon Rifled Ordnance, &c.; all connected with warlike affairs. Then there are models of ships, forts, arms, battles; and there is a collection of relics or trophies, naval and military. For example, as to naval relics, there are the sword worn by Nelson when he took the "San Josef," the chronometer used by Cook in his voyages of discovery, the signal book of

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* The Crown its Patron.

the "Chesapeake," and many others. As to military relics, they have the swords of Cromwell and of Wolfe, the sash with which Sir John Moore was lowered into his grave, Napoleon and Tippoo Saib's rifles, relics of Waterloo, Inkermann, Sebastopol, and others. The Duke of Wellington took much interest in this institution in all its departments, and entered most kindly into the wishes of the Council regarding digging up and placing the skeleton of his favourite horse, which he rode at Waterloo, into the museum, as already they had the skeleton of the Arab rode by Napoleon at Waterloo. The design never was accomplished, but the museum of relics called forth a quiet jocular remark from the great commander to Sir Charles Napier; and as the jokes of the Duke of Wellington are rare, I may mention it in passing. It is the more amusing, as Napier used to tell the story himself. Whilst the negotiation about the skeleton of the Duke's horse was going on, Charles Napier, the naval officer of the name, had been dining at Walmer Castle with the Duke, as his ship lay in the roads. On going away, Napier was putting on his cocked hat, as he was in uniform. Charles Napier, it is well known, was not very nice as to his wardrobe; and so, as they had been talking about the museum, the Duke, after eyeing the cocked hat, suggested, "Napier, you should put your cocked hat into the museum—just the place for it."

The immense increase of scientific associations for the furtherance and pursuit of separate branches of human knowledge is no more than what might have been expected, and is, in fact, the natural supply of that vastly increased and increasing demand for knowledge in all departments of study, especially in those which relate to inquiries connected with the physical sciences. Nor does this increase at all act injuriously upon the older societies, or deteriorate from the usefulness or importance of their office. It rather calls out their exertions, and places them in a *more* important position. It was utterly impossible that they should of themselves meet the whole growing demand except by a subdivision of their own body, which would not certainly have been so efficacious an arrangement as the formation of new bodies. These children, if we may so call them, of the parent societies, instead of being rivals and opponents, are I apprehend, their best aids and coadjutors. The younger branches take, as we might say, the heavy work of departments, whilst the older institutions take that general charge which extends itself to the whole field of human knowledge. No subjects are excluded from the parent society, but none should have a monopoly there. Whatever other societies do they are ready to do; and in their Proceedings a full and free admission should be given to those subjects which cannot so properly find a place elsewhere. I cannot help thinking that this great multiplication of associations for the exclusive advancement of so many distinct branches of natural science, should lead the older and parent societies to *extend* as much as possible the basis of their own operations. The student who finds only his own pet study advanced by the association which bears its name, naturally looks for a greater variety of subjects in the Royal Society, to which the name of no particular science is attached. The course now pointed out to us is to take the widest range of questions connected with the pursuit of truth; and this seems to me a strong argument for a more frequent introduction of literary papers. Botanical or entomological societies draw round them only botanists and entomologists: The Royal Society should draw round it men of all pursuits. The continued absence of literary papers naturally excludes the full sympathy and cordial co-operation of those who are keenly interested in literature, but who do not take interest in minute details on scientific questions, whether of natural history or natural philosophy. My argument, then, in one word is this: That as ordinary scientific societies attract only those who pursue the studies to which they are specially dedicated, so the Royal Society is intended to attract and interest all classes of men of research and intelligence. I am aware that I require apology for making these remarks; but I offer them not only under a deep feeling of their importance, but from an assurance that persons whose valuable aid and countenance we would be proud of are kept away, because the Society's papers and discussions are so seldom upon questions other than those connected with physical inquiries.

After these remarks upon the labours of the Society past and future, I would say a few words on those of our body who have departed this life since we met within this hall last December. I think the practice adopted of late years by the Royal Society of Edinburgh, and which has been pursued by other kindred associations,—I mean the practice of introducing, at the opening meeting of every Session, a short biographical reference to the deceased members of the past year,—is a most becoming and appropriate arrangement.

Whilst, on the one hand, it enables the chairman to offer a suitable testimony to many a distinguished example of zeal for literature and science, and of well-directed labour in their cause, and whilst he is thus enabled to enlarge upon ingenious discoveries and useful inventions, at the same time it indicates a very becoming feeling of interest in the Society towards its individual members as fellow-citizens, and as companions embarked in a common cause, and is a graceful recognition of them in their private character, showing the friendly bond by which we are united, as associates of an ancient and distinguished literary and scientific institute. Sir R. Murchison seems to have had this feeling strong in his mind during his address to the Geographical Society in 1859. In taking leave of the chair he says, " With truth, I take leave of my dear friends as the really *good* fellows of the Royal Geographical Society;" and surely the Royal Society of Edinburgh has just cause to be proud of many names who now bear, and who have in times past borne, the title of Fellows. The present roll of the members embraces many persons distinguished not only at home, but amongst the philosophers of Europe. In the list of past members are recorded names imperishable in the annals of history,—names associated with the highest productions of the human mind. This we may fairly say, when amongst our departed members we find such names as Hume, Robertson, Black, Adam Smith, Sir Humphry Davy, Sir Walter Scott. Now, in looking back upon the changes which the past year has made in our list of members, we find that those whom we have lost were all men of a certain degree of weight and influence in their position in society; all were men much respected by their cotemporaries, and men whose death called forth many sincere expressions of sympathy and regret. It is somewhat remarkable that none of these members belonged, properly speaking, to the *scientific* department of the Society. No one had adopted the pursuit of pure mathematics, or their application to the laws of nature. None were geologists, chemists, or naturalists, beyond that general acquaintance and intelligence possessed now by most men of education. Our deceased members were well known, however, in connection with the business of their day. We have to mark a past career which is associated with a high place, indeed the highest place, in the government of the country. We see the vacant places of men who were no ordinary proficients in the discharge of life's duties, and the more particular duties to which *they* were called, whether it were as ministers of state, as judges, as professors in the university, as landed proprietors, as theologians, or lawyers. The following is the list of departed Fellows of the Society:—

Right Hon. the Earl of Aberdeen, K.G. & K.T.
Robert Bell, Esq., Advocate, Edinburgh.
Right Hon. Lord Campbell, London.
John Gordon, Esq., Cairnbulg, Aberdeenshire.
Professor J. Shank More, Edinburgh.
Sir James Miles Riddell, Bart., Strontian.
The Rev. James Robertson, D.D.
E. D. Sandford, Esq., Advocate, Edinburgh.*

Of the late members on our obituary list, the first is the name of a statesman, a man of the world, a scholar, an antiquary. George Hamilton Gordon, K.G. and K.T., fourth Earl of Aberdeen, was born in 1784, and died December 14th, 1860, at the ripe age of seventy-six. Although far from what would be called a man of brilliant talents, or of great powers of oratory, still, during this long life, few men were more distinguished as filling with much ability high and responsible positions, few were more respected for private worth, and few more generally known for scholar-like attainments. Lord Aberdeen was educated at Harrow, where he laid the foundation of a classical taste and acquirement such as I am disposed to think nothing can so effectually accomplish as an English public school. He went to St John's College, Cambridge, and graduated there in 1804. But previous to this he had been attached to the embassy at Paris, and had gone with Lord Cornwallis, who was there as our ambassador to negotiate the Peace of Amiens in 1801. He formed intimacies with many leading men of the day, and commenced that knowledge of continental politics for which he afterwards became so celebrated, and from which he was enabled so long to administer with much skill and ability the Foreign Department of the British Government.

He did not remain long in Paris in 1801, but before returning to England travelled in Greece, where he brought his classical attainments to bear upon his study of the beautiful architectural remains and interesting localities of the country. This sojourn in Greece (when access to foreign parts was less open to British travellers than it is at present) procured for Lord Aberdeen the

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* The names are alphabetically arranged.

notice of his kinsman Lord Byron, who in the English Bards and Scotch Reviewers introduced his name with the well known line—

> "The travelled Thane, Athenian Aberdeen."*

The public official career of Lord Aberdeen; his frequent occupation of high place in the administration of his country's affairs; his close intimacy with the most distinguished foreign public characters of his time, especially his friendship with Guizot and Prince Metternich; his modification of opinion on many points of national policy, and of the high Tory principles with which he commenced life, which ultimately led to his heading a coalition ministry composed of politicians of all shades of opinion; his correspondence with Dr Chalmers on Scottish ecclesiastical matters, and his endeavours to prevent that which was not prevented taking place, viz. the disruption in the Scottish Established Church; his constant and undeviating advocacy of the policy of non-interference on the part of the British Government in continental relations, and his aversion to entering into war with Russia, and the temporary unpopularity which from that cause he incurred with his own countrymen;—these are all now matters of history, and belong to history, and we leave them to the historian.† As a late Fellow of the Royal Society of Edinburgh, we look more to the man and the scholar than to the politician. To whatever part of Lord Aberdeen's career we direct our attention we find everything that claims our respect and approval. As a landed proprietor his whole career was marked by energy, by skill, and great liberality. I am assured that on no property in Scotland were greater changes manifest under the direction of the proprietor than on his; and all changes were improvements. Old persons, I am assured, in the neighbourhood of Haddo House, speak of once barren moors becoming cultivated farms—once sterile tracts of country becoming clothed with beautiful and valuable timber. A friend who was on a visit to him shortly before his death, exclaimed, after

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* In 1813 he returned to the Continent, and was our ambassador to the Austrian Court; there he was long engaged in cementing the alliance formed against the power of Napoleon. He was present at many great battles,—Lutzen, Dresden, Leipsic—Moreau died in his tent at Dresden; and it was his impressions received from these dreadful battles that gave Lord Aberdeen that great horror he entertained for war through life.

† A kind friend informs me that the best account of Lord Aberdeen's public life is a memoir by Comte de Jaumais, in the "Revue de deux Mondes." But I have not had time or opportunity for consulting it.

Lord Aberdeen had been pointing out to him the success of his plantations in magnificent and extensive woods, "You don't mean that you planted all these yourself?" "Yes," replied the peer; "and perhaps you will believe what I have before told you, that my line was not politics," but farming. In this light of a Scottish proprietor, we must ever consider him as a patriotic and judicious benefactor of his country. Lord Aberdeen was for many years the efficient President of the Antiquarian Society of London, and no one was more fitted for such an honour. He was an accurate scholar, and a patient investigator into the remains of antiquity. It is curious to observe how Lord Aberdeen preserved, through all the circumstances and stirring incidents of an unusually exciting period of public affairs, the love of classical literature which he had imbibed at Harrow, at Cambridge, and at Athens. His mind had been early imbued with a fine taste for the best writers of Greece and Rome, and the effects were visible to the last. It is often, I believe, thus a taste for life—

> "Quo semel est imbuta, recens servabit odorem
> Testa diu."

We have specimens of his accurate scholarship and ingenious criticisms in his contributions to Walpole's "Memoirs on Turkey," and in his work on the "Beauty of Grecian Architecture."

In 1817 a book was published entitled "Memoirs Relating to European and Asiatic Turkey, Edited from MS. Journals, by Robert Walpole." It consisted of such extracts from the journals and portfolios of intelligent and learned travellers, who had of late years visited that interesting portion of the globe, as were calculated to throw light upon its present condition and ancient grandeur, its geography, antiquities, and natural history, recorded, too, in their own language. It is a very valuable and interesting collection. Amongst these papers are some very learned dissertations by Lord Aberdeen; one of these is upon the gold and silver coinage of Athens. A curious question had been agitated by scholars on the subject of Attic coinage, and many learned men have held that the Athenians never coined gold money at all. There was no doubt gold money, but it seems to have been in coins of other countries. Gold coin seems to have been the *stater* of Persia or Egina, or the ancient *δαρεικος*, so called from Darius. Aristophanes speaks of gold coinage, but in his mocking way calls the pieces *πονηρα χαλκια*, which is not, as Corsini thinks, *copper* money, but base gold money,—*i.e.*, gold alloyed with copper. Now, Lord Aberdeen discusses the question with much learning and ingenuity; and I will give his conclusion in his own words, as a specimen of his critical style, because scholars are agreed that he settles the question by a more satisfactory explanation of the difficulty than had been given by others.

"The currency of the SILVER money of Athens was almost universal, owing to the deservedly high reputation for purity which it possessed; and on this account we find several cities of Crete copying precisely in their coins the design, weight, and execution of the Attic tetradrachm, in order to facilitate their intercourse with the barbarians. It is possible that the general use and estimation of the produce of the Attic mines contributed to render the Athenians averse from a coinage of another metal, which, by supplying the place of silver money at home, might in some degree tend to lessen its reputation abroad."

"The Attic silver was of acknowledged purity, and circulated very extensively; the Athenian merchants, particularly in their commercial dealings with the more distant and barbarous nations, appear frequently to have made their payments in it. The barbarians, being once impressed with these notions of its purity, the Government of Athens, in all probability, was afraid materially to change that styled appearance by which their money was known and valued among these people. A similar proceeding in the state of Venice throws the strongest light on the practice of the Athenians. The Venetian sechin is perhaps the most unseemly of the coins of modern Europe. It has long been the current gold of the Turkish empire, in which its purity is universally and justly esteemed; any change in its appearance on the part of the Venetian Government would have tended to create distrust."

Lord Aberdeen in this volume gives an account also of two curious sculpture marbles found at Amyclæ in Lacaonia. Each of these two marbles represents a hand-basin surrounded with various implements of a female toilet—such as combs, pins, a bodkin, perfume-boxes, bottles, mirrors, curling-irons, toothpicks, and reticules, or, as some learned men believe, nightcaps. On one of these stones is an inscription containing the words, *Ανθουση υποστατρια;* on the other an inscription containing the words, *λαοχγητα* and *ιερεια*. These by some are supposed to signify two priestesses—Anthusa and Laoageta being supposed the names of priestesses by whom the stones were dedicated.* Others, again, consider *στατρια* to be nothing more than a hairdresser, and *υποστατρια*, an under-hairdresser—the same as an *ἐμπλεκτρια*, or a tirewoman; and the stones, therefore, to be a sort of advertisement of their profession by Anthusa and Laoageta. Lord Aberdeen follows out these nice and critical inquiries with much learning and much patience, and with similar clear and convincing effects as in the case of the Attic tetradrachms.

The treatise of Lord Aberdeen, of which the title is "An Inquiry into the Principles of Beauty in Grecian Architecture," was originally contributed as a preface to Mr Wilkins' translation of Vitruvius. It was published afterwards in a separate form by the author, and has lately been brought out by Mr Weale, the architectural publisher, at the moderate price of one shilling. If we knew nothing of Lord Aberdeen's scholarship except by this treatise, we should have abundant proof of its accuracy, its elegance, and its extent. The essay shows a masterly hand in treating the subject. Nearly all the celebrated buildings of ancient Greece are brought before the reader, and their characteristic features are discriminated with a skilful touch. The whole question of the origin of architectural forms is discussed in reference to the inquiry into the principles of beauty in Greek architecture, although I cannot help thinking that he loses sight of that point at times. Lord Aberdeen disputes, and indeed refutes, the theory of Burke on the sublime and beautiful, and supports himself the theory of beauty as grounded on association—the theory of Mr Alison, as developed in his Essay on Taste, and as admirably supported and illustrated by Francis Jeffrey in his celebrated critique on Mr Alison in the "Edinburgh Review." I would speak with much diffidence on such a question, but I cannot help thinking there is very little satisfaction in these *theories* of beauty, and inquiries into the *principles* of beauty. The idea of beauty is too refined and too delicate to admit of such analyses and dissections. The application of female dialectics to beauty, vulgarly called a woman's reason, is after all more satisfactory than analysis and theory. It is beautiful, *because* it is beautiful; so we say of the orders of Greek architecture. There is a severe and simple grandeur in the Doric, with its firm-set columns, its massive triglyphs, and deep entablature; there is a grace in the Ionic, with its more slender

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* As the *κοσμητριαι*, or ornamenters of some deity.

shaft and beautiful volute; there is an elegance combined with rich luxuriance in the Corinthian, with its acanths capital,—which baffle all theory, which speak to the eye without any explanation being needed on the grounds *why* they should be admired. These remarks, however, affect not the great merit of the treatise I speak of. Lord Aberdeen's work on Grecian architecture is a work which no one should be ignorant of who desires to see the subject handled with scholarship, taste, and discernment.

It is always interesting to know something of the personal appearance, the ordinary address and manners, of the distinguished dead. Lord Aberdeen, though a man of high birth, of public status, of elegant and refined tastes, was to a great degree plain and unpretending in manner. He had, perhaps, a good deal of that cold and reserved demeanour which obtains for the British character, especially for those in high positions, the name of an exclusive, haughty treatment of others. It is often, as in the case of Lord Aberdeen, a most fallacious mark of the real feeling and the true kindness of the heart within. I might have spoken on this point in some measure from my own observation, as I had the honour of personally knowing Lord Aberdeen. But I prefer offering the picture of Lord Aberdeen's personal appearance and manner as they were observed from a different and most impartial point of view,—I mean as they struck the mind of a stranger, and that stranger a visitor from the United States. In the year 1835 a literary gentleman, Mr N. P. Willis, from America, visited this country for the express purpose of writing a tour, which was published in due time under the title of "Pencillings by the Way." He had been introduced to the Earl of Dalhousie, father of the late distinguished Marquis of Dalhousie, and was received at Dalhousie Castle, where I met him,—and an acute, unscrupulous observer he was. Lord Dalhousie introduced him to the late Duke-of Gordon, and at Gordon Castle he was introduced to the late Lord Aberdeen, of whom he thus writes:—

"Lord Aberdeen has the name of being the proudest and coldest aristocrat of England. It is amusing to see the person who bears such a character.

"He is of the middle height, rather clumsily made, with an address more of sober dignity than of pride or reserve. With a black coat much worn, and always too large for him,—a pair of coarse check trousers, very ill made,—a waistcoat buttoned up to his throat, and a cravat of the most primitive *negligé*. His aristocracy is certainly not in his dress. His manners are of absolute simplicity, amounting almost to want of style. He crosses his hands behind him and balances on his heels; in conversation, his voice is low and cold, and he seldom smiles. Yet there is a certain benignity in his countenance, and an indefinable superiority and high breeding in his simple address, that would betray his rank after a few minutes' conversation to any shrewd observer. It is only in his manner toward the ladies of the party that he would be *immediately* distinguishable from men of lower rank." (*N. P. Willis' Pencilling by the Way.*)

Here we find an American tourist brought into contact with the British nobleman, surprised at not finding a man exhibiting all the artificial graces which he had supposed were shadowed forth for all men of rank in England by Chesterfield's Letters; and yet the republican has acutness enough to discern, under the cold and simple demeanour of the peer, the high estimable qualities of head and heart by which his character was impressed. He feels how much lies beneath, and he is impressed with respect and admiration. He was right in the estimate he formed of him; and further acquaintance would only have deepened the impression of his high qualities. From one who had the first opportunities of judging, I have this testimony, that "he considered him the *best* man he ever knew. That he really believed he was incapable of even comprehending anything mean or ignoble." Such, then, was Lord Aberdeen in his various relations and features of character. He was no ordinary man,—consider him as a statesman or scholar, a man of property, or in his more private relations of life. It is a great blessing when men who are called upon to take so prominent a place in public affairs are really *good* men. The Royal Society of Edinburgh, of which he was a member for years, his family, his country, respect the memory of the late Earl of Aberdeen.

Mr Robert Bell, was son of Benjamin Bell, the celebrated surgeon. He was born in 1782, was educated at the High School of Edinburgh, and was called to the bar in 1809. He must soon have gained some reputation as a lawyer, as he appears in an early caricature of Kay as one of those advocates who pleaded in a wig.

From this period he gradually attained considerable practice. He was made Procurator for the Church of Scotland, and Sheriff of Berwickshire in 1842. Mr Bell had, besides his legal acquirements, a highly cultivated mind. He was fond of mathematical reasoning as a recreation, and did not further apply it. In art he had excellent taste; and indeed was considered by picture-dealers to have great knowledge of the old Masters, and much tact to discriminate their styles. He made, from his own judgment, a collection of Rembrandt etchings, considered one of the most complete in the kingdom. Mr Bell was a member of the Bannatyne Club, and not an inactive member. He was a great reader, and deeply conversant especially with works on philology. Those who knew him well bear high testimony to his varied powers of conversation, and his skill in discussing and elucidating subjects that were brought forward in society.

A certain George Campbell having injured his property by adherence to his chief, the first Marquis of Argyle, during the trying times of the Covenant in 1662, left the Highlands, and became the proprietor of the estate of Baltulla in the neighbourhood of St Andrews. The great-grandson of that George Campbell was the Rev. Dr George Campbell, for fifty-four years the minister of Cupar-Fife. In 1776, Dr Campbell married Miss Hallyburton, who was connected with some Scottish families of rank, of whom one was Wedderburn, Lord Chancellor. The fruit of this marriage was five daughters and two sons. Of the sons, the elder was Sir G. Campbell of Edenwood; the second was John Campbell, born at Springfield, near Cupar, September 15, 1781, afterwards destined to rise by his own talents and industry to become a peer of the realm, Chief-Justice of the Queen's Bench, and Lord Chancellor of England. Lord Campbell was always proud of his connection with the Argyle family and with Scotland .He showed this by his kindly and interested allusions to the Campbell clan, which very frequently show themselves in his "Lives of the Chancellors;" and when Lord Chancellor himself he marked his feelings as a Scotchman by thanking most warmly the author of an idle book, called "Reminiscences of Scottish Life and Character," when the writer was presented to him, for the great pleasure he had derived from these old stories of a bygone Scottish race. He showed also more decidedly his love for Scotland by purchasing Scottish property, and living in Scotland as much as he was able. I have observed that in all his publications he is very particular in having F.R.S.E. appended to his name as author.

Lord Campbell was educated at St Andrews, where he was a cotemporary of Thomas Chalmers and of David Wilkie; though younger than either, for it appears he entered St Andrews at the precocious age of ten. Young Campbell was intended for the ministry, but he soon found that his calling was not to the Church. His sense of unfitness for clerical studies, joined with ambition to shine at the English bar, led him to London. Mr Sergeant Spankey, then editor of the "Morning Chronicle," gave him employment as reporter and critic. He seemed to have retained his connection with that paper up to 1810, and, what is curious, chiefly as a dramatic critic, writing theatrical articles. Young Campbell showed also at this time that he could claim resemblance to accomplished Roman lawyers, and, for example, to one celebrated by Horace—Asinius Pollio—who was not only a lawyer and statesman, historian, and conversant with the "musa tragœdiæ," but *soldier* also, as Campbell had joined the Bloomsbury and Inns of Court Volunteers, which consisted exclusively of barristers, attorneys, law-students, and clerks. To this circumstance he jocularly referred in after life, in a suit he was trying connected with a volunteer regiment, by saying that he had himself once been a soldier, as a member of the corps, composed as I have said of diverse members of the legal profession, and which he referred to as well known in the capital under the name of *The Devil's Own*. His great object, however, was *law*. He entered as a student of Lincoln's-Inn in 1800, and commenced special pleading under that great master of the art, Mr Tidd, who at one time could point to four pupils of his own sitting in the House of Peers,—Lords Lyndhurst, Denman, Cottenham, Campbell,—all of whom constantly acknowledged their deep obligation to their master. He was called to the bar in 1806, and went the Oxford Circuit, where he soon obtained considerable practice. It was to London business, however, that he looked, and he was soon in great London practice—getting high fees in shipping cases, and in special jury cases at Guildhall. It is well known that in establishing practice for a young lawyer much depends upon the favour with which he is regarded by the attorneys. Lord Campbell in his "Life of Pratt," Chief-Justice of the King's Bench, and father of the Marquis of Campden, says of him, that for eight or nine years his practice did not improve, because he would not invite the attorneys to dinner, or dance with their daughters. Whether Campbell was a dancing man, or whether he danced with attorneys' daughters, I know not. But it is clear that he took a better and a more lawyer-like plan of gaining the favour of their papas than either dancing or dining. He published a series of Reports of Cases decided at *Nisi Prius* between 1809 and 1816, which was not only in itself very valuable, and established his reputation as a lawyer, but which specially interested the body of solicitors, as the work contained for the first time the names of the attorneys who had got up each case. He had thus very early a great connection with the solicitors, and came into a lucrative and immense business. He soon became leader on the Oxford Circuit. In 1827 he obtained a silk gown. In 1830 he came into Parliament for Stafford. In 1832, was Solicitor-General in the Melbourne Ministry, and was returned to Parliament for Dudley. In 1834, he became Attorney-General on the retirement of Sir William Horne, but lost his seat for Dudley. On Mr Jeffrey's elevation to the Scottish Bench, and consequent retirement from the representation of Edinburgh, Sir John Campbell was returned as one of our city members, and sat till 1841.* Several very important cases in the common law-courts occurred whilst he was Attorney-General, in which he had to take a prominent part. One of his most conspicuous efforts was his defence of Lord Melbourne, the prime-minister, in the action brought by Mr Norton. Campbell's defence was considered so masterly, and the gaining the cause so important to the stability of the administration, that when Campbell entered the House of Commons the evening of the trial, he was generally and loudly cheered by the members on the ministerial side of the House, as a testimony to his skill in managing the case. and his ingenuity in cross-examining the adverse witnesses. At this period many law appointments had to be made, but Sir John Campbell still continued Attorney-General. A purpose of bringing

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* Sir John Campbell, whilst a member of the House of Commons, did good service to the country by promoting at all times the cause of legal reforms. He introduced two very important bills which are known by his name. One for the protection of proprietors of newspapers who had inserted libels without malice of purpose, and having made due apologies. The other for the protection of persons against malicious arrest for debts which were not due. The latter arose out of a famous case of arrest, and great hardship, of the Duke of Caduval on a false affidavit.

him into the House of Peers to assist in deciding appeal cases failed, as did also a plan for making him Chancellor of Ireland. On Lord Plunket's retirement, however, from that office, Sir John Campbell, June 1841, was made a Peer and Chancellor of Ireland. He held the office a very short time, indeed I believe he only sat as judge twice. In the following September, he resigned along with the Melbourne ministry, and for five years lived without office, profession—salary or pension. His mind could not be idle. He took to literary pursuits, and reverted with great zest to the classical studies of his early days. He found, however, the disadvantages of study without object, and accordingly concentrated his attention on a subject congenial with his tastes, and calculated to call forth his powers. He determined to write the Lives of the Chancellors, and of the Chief-Justices of England. The first series of the former was published in 1846, and immediately attained a popularity which has continued to attend both works. When Lord John Russell's cabinet was formed in 1846, it was expected that Lord Campbell would have been Chancellor. He accepted, however, the less important office of Chancellor of the Duchy of Lancaster, with a seat in the cabinet. This did not prevent his pursuing his literary labours; but in 1850 he returned to his more active legal occupations, as, on the resignation of Lord Denman, he became Chief-Justice of the Queen's Bench. It was a trial to succeed Denman, a man of a noble presence, and dignified eloquence. Lord Campbell, without these, carried universal respect by his accurate knowledge of law, his industry, his discretion, and impartiality. In 1859 he became the Chancellor of Lord Palmerston's administration. This was a second trial for him to undergo. Having hitherto been exclusively practised in the administration of common law, it might be expected he would feel embarrassed as presiding in Chancery, and the House of Lords. But his sagacity and his diligence were again triumphant. He lost nothing of the reputation he brought with him from the Queen's Bench. He is said to have been the only Chancellor taken from the common law, in whom it was impossible to detect the slightest embarrassment in the new position to which he was transferred, and amidst the new principles on which he had to adjudicate. His judgments in equity have universally been deemed of the highest authority. It is a striking proof of the activity of Lord Campbell's mind, and his readiness, to occupy his time and thoughts with questions not immediately connected with his professional occupation, that he should have sustained so long and so important a literary effort, as writing the lives of the Lord Chancellors and Lord Chief-Justices of the Queen's Bench. There is no question of its being a work of great research, great impartiality, and full of acute and able remarks; the stores of information are at once various and minute; the style is far from being polished, but he is always clear and intelligible to his reader; he has done his work thoroughly and well. He happily unites the office of the lawyer and the historian; for the careful law-student of the work will find in the personal history of our Chancellors and Chief-Justices that there is also pervading it a history of our *jurisprudence*. He will trace the gradual establishment of its sounder principles, he will mark the correction of what had been vague or erroneous.

But there is another and a more striking indication of the activity of his mind, and the versatility of his talent, as regards questions which did not come before him as a judge, which is contained in his letter to Mr Payne Collier, on the Legal Acquirements of Shakspeare. He had glanced at this subject in his "Lives of the Chancellors and Chief-Justices." But in this letter, he brings forward the arguments in favour of an opinion, which had for sometime been gaining ground amongst the admirers of Shakspeare—viz., that before he went to London for his theatrical life, he had been clerk in an attorney's office at Stratford. There are some cotemporary circumstances which seem to lead to this opinion, and these Lord Campbell states in the opening of the letter; but his chief argument is derived from the corroborative evidence supplied by passages selected from his plays. He quotes from twenty-three plays, and he conceives that the passages he quotes give a *probable* evidence that they must have been written by one who had once been a professional lawyer, and familiar with its technical language. I have heard persons speak rather in a depreciating manner of this little production, and who seemed to consider it as unworthy of Lord Campbell, and in fact as in itself of little interest. I am much surprised at this opinion. I think the case is made out in a very ingenious manner; and surely it cannot be a matter devoid of interest to trace back any of the sentiments and expressions of Shakspeare to their original sources, and to analyse the materials of a mind like his. That Shakspeare who drew his imagery and his topics from all sources in society and in nature, should refer in a general manner to the legal profession, and to lawyers, as a peculiar and marked class of civil life, could have caused no surprise. It would have been quite natural. But when he uses such technical language as can be familiar to professional men only, when his illustrations imply an accurate knowledge of legal principles not generally known, we feel assured that there must be some special cause for materials of such a character being introduced into his writings so frequently and so minutely. It was natural enough, for example, that Shakspeare should say of skilful lawyers, "good counsellors lack no clients," or of lawyers, who are idle in vacation time, that they "sleep between term and term," or that he should call time "the common arbitrator." That Gratiano would propose for Shylock, besides his two godfathers, when he became a Christian, *ten more*, meaning that he would have him before a jury to be tried for an attempt to murder Bassanio; or that the fool in Lear should say that the maxims which the old king declared were "nothing," were like "the breath of an unfeed lawyer, given to the king for nothing," and many other examples. But it is very different when he uses terms and makes representations, which imply a knowledge of nice points of law, and points not generally known, except by professional men. As, for instance, in the "Merry Wives of Windsor," Ford says, that "his love was like a fair house, built upon another man's ground, so that he had lost his edifice by mistaking the place where he erected it," showing that Shakspeare had a knowledge of real property not generally possessed,—viz., the knowledge of that maxim of lawyers applicable to land: "cujus est solum, ejus est usque ad cœlum," under which any house erected on a freehold becomes the absolute property of the soil,—so that the luckless builder cannot remove any of the most costly adjuncts of his building, such as the finely-carved chimney-pieces, or expensive marble pillars, with which he may have adorned the edifice. A passage in the "Comedy of Errors" draws out a most circumstantial and graphic account of what is called in English law "Arrest on Mesne Process in an action on the case." No one could have adopted the phraseology in the conversation between Adriano and Dromio, who had not a technical acquaintance with the point of law so named. It is very curious also, that Shakspeare, in the grave-diggers' scene, where he speaks in a ludicrous tone of "Crowner's Quest Law,"—*i.e.*, the law as laid down by a coroner when he holds an inquest on a dead body—should show his intimate knowledge of a celebrated case of *felo de se*, tried in the reign of Philip and Mary before a coroner, and which was afterwards brought into the higher courts. The case had been reported by the famous Plowden, and Shakspeare evidently intended to ridicule the counsel who argued, and the judge who decided it. Hamlet's own speech quotes a string of technicalities, with the meaning of which the author is apparently familiar,—such as speaking of a lawyer's recognisances, his fines, his double vouchers, his recoveries, and of these vouchers, whether single or double, vouching him no more of his purchases than a pair of indentures,—and of which Lord Campbell declares that it would puzzle practising barristers of his acquaintance to define each satisfactorily; and let it be remembered, that Lord Campbell quotes upwards of sixty examples of such law passages more or less to the point. Whether Shakspeare were or were not trained in an attorney's office can never now be known beyond conjecture, but the book shows Lord Campbell's ingenuity, and his readiness on a question of law and literature in curious combination.

Such is a brief sketch of the active and varied life of John Lord Campbell. He was assuredly a very able man, and has achieved a name in his country's annals which will not pass away. The leading characteristic of his mind, as I have always heard from those who knew him best, was *determination*—a firm resolve to accomplish his object before him, and to attain the highest place in the path he had set himself to pursue. His efforts were successful, and he never relaxed in his diligence, never swerved from duty. A little incident will illustrate this adherence to what he considered was incumbent on him to accomplish, at all risks to his own personal convenience. When the naval review took place at Portsmouth, in 1853, the nobility and leading commoners of the empire were to attend, and a steamer was appointed to convey the whole House of Lords from Southampton, and to bring them back to the same point when the review was done. They were obliged to start from London, the day of the review, at four in the morning, One mishap succeeded another, so that the party did not reach Southampton till three the following morning, and were not in London till six. Notwithstanding all the fatigue and delay of so long an expedition, Lord Campbell, then Chief-Justice of the Queen's Bench, was enabled to state in the House of Lords, with great complacency, when complaints were made of the bad arrangement of the expedition, that the suitors had not suffered from the mismanagement, as he had taken his seat in Queen's Bench at the usual hour, half-past nine. He was then seventy-two.

Lord Campbell owed his success in life entirely to his own exertions, and his own innate powers of mind. He had not those external accessories of address or grace to which men are sometimes indebted for much of their success, and from which they gain artificial advantage in the public eye and estimation. He was plain, in his exterior, nor had he a polished style of writing or of speaking. He had nothing of what is usually termed eloquence, and yet all he said and wrote *told* and produced good effect. Like Lord Aberdeen, he enjoyed in his lifetime the respect and consideration due to his talents and his success, but which are posthumous to so many good and able men. For him a cotemporary might very properly use the address made to Augustus, "*Presenti* tibi maturos largiamur honores."

Lord Campbell never felt what so many able men feel before they have to give up their place in this world,—viz., that "multa senem circumveniunt incommoda." He had only *one* of those two seasons of childhood which Shakspeare has assigned to every human being, nor could he ever have said with Lear:—

> "Infirmity doth still neglect all office,
> To which our *health* is bound."

He died in his eightieth year, in the midst of full occupation as a statesman and a judge, and with faculties, I believe, quite unimpaired. Few men can hope ever to attain Lord Campbell's eminence; few can expect to reach his years without infirmity and decay of mental and bodily faculties. But all may imitate his example in the fixed determination to do their utmost in the path which Providence has assigned to them, and all may follow him in the full resolve faithfully and honestly to discharge every duty for which they have become responsible.*

John Gordon, Esq. of Cairnbulg, who died during the present

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* Those who best knew Lord Campbell in *private* life bear testimony to his amiable and affectionate deportment in the domestic circle. To his habitual unselfishness, which made him seek the comfort and happiness of every one before his own, and to the freshness and simplicity with which he enjoyed, with young people especially, the few simple pleasures for which his immense labours left him time.

year at an advanced age, had long been a Fellow of the Royal Society. He spent many years in Edinburgh, and at one time was in some practice as an advocate. I recollect him a regular attendant on the Society's meetings. But his natural bent was towards the duties and avocations of a country gentleman. These occupied his attention during the later years of his life. But he joined, with all his pursuits, a love of literature to the last, and, with much intelligence, took great interest in everything that was going on at home or abroad in the fields of scientific and literary inquiry.

John Schank More was born at North Shields in 1784, where his father was the respected pastor of a congregation in connection with the first seceders from the Scottish Established Church. He was educated in Edinburgh, and had an early predilection for the bar, to which he was called in 1806. He had good practice as a junior counsel, but he soon showed that his bent was rather to the teaching of the profession, and the exposition of the general principles of law as its expounder, than to the practice of court. In 1827 he published an edition of "Erskine's Principles of the Law of Scotland," a very useful manual for guiding young students to a correct knowledge of that standard manual. But in 1832 he published his most important work, his edition of Lord Stair's "Institutions of the Law of Scotland, with Notes and Illustrations." Lord Stair's work was the production of a most philosophical mind, as well as of a profound lawyer. It contains more than a digest of municipal law, it contains an able treatise of general jurisprudence. His illustration of such a work, therefore, fell in with Professor More's peculiar habits of mind and thought. I have been assured by an eminent Scottish lawyer, that he was particularly happy in bringing forward all circumstances in illustration of his abstract law principles, whether derived from home or foreign sources. He had extraordinary knowledge of what may be termed the *literature* of the law. Hence his edition of Stair has taken its place as a standard work, and is quoted for general principles, both at the bar in argument, and on the bench in judgment. A course of study producing such happy results as the Professor's labours in the two great works of Erskine and Stair must have been recognised as the best preparation for a legal chair, and the best proof of fitness for its occupancy. Accordingly, in 1843, on the death of Professor John Joseph Bell, he succeeded to the chair of Scots Law in the University of Edinburgh. It would be unbecoming, in one not a lawyer, to pretend giving a judgment on the merits of a professor's teaching of law. But that he performed his work under a solemn sense of duty—that he spared no pains to make his class understand the principles and the details of a science which he had diligently and successfully studied himself, is a matter of general notoriety, and the public papers, at the time of his death, all bore testimony to his merits as a professor. One feature of his professional work was very remarkable, and attested by every hard-working student, I mean the unwearied pains he took in going over their papers, and the careful manner in which he corrected the essays sent in to him. There may be something animating and attractive in looking over the exercises and theses of Scots law students, I am unable to judge of this, but I should think, in general, such examinations must be a dreary portion of any professor's labours. But Professor More never seemed to weary. He never intermitted his care, and seemed always fresh for doing, and doing kindly, what he considered an act of duty by his pupils. Professor More, in fact, made his studies, and everything connected with his profession, a part of his daily and ordinary life. He enjoyed books, because he made good use of them, and he had collected a library of upwards of 15,000 volumes. These books were his delight—his companions in solitude, his comfort in the tedium of hours of sickness. He could turn at once to the volume he wanted, and to the passage he desired to recall. When I say his books were his companions, I might rather have said the *authors* were his companions. In a letter to one of his family, shortly before his death, he draws in himself a pleasing picture of an old man in his study surrounded by his books, and holding converse with his favourite authors:—

"While reading Leighton quietly in my own room, it struck me that the old man was really sitting with me, and conversing familiarly upon those topics which so entirely engrossed his own mind; and it is a curious reflection that, with such books, I have been conversing as truly with Horsley, Hooker, and Leighton as if they had risen from their graves and sat by me."

Whilst I remark the Professor's liberality of feeling in naming as his favourites three authors who were *not* members of his own Church, I think my hearers will excuse some personal feelings ot pride and satisfaction in observing that Leighton, Horsley, and Hooker are ornaments of my own Church.

There is a circumstance connected with the late Professor's library which was so peculiar that I cannot resist referring to it. He was a most indefatigable collector of PAMPHLETS, and formed the largest collection of a private individual, I believe, in Scotland; and it is always curious to notice what any man has done different from other men. Some years ago I had the honour of reading before this Society a memoir of my illustrious friend Dr Chalmers. Professor More heard of my intention, and very kindly offered me the use of a volume, which he had collected, of sermons, memoirs, poems, &c., all relating to Dr Chalmers. I found this one of a series of volumes of collected fugitive pieces, then amounting to 700 or 800; but which, before he died, the Professor had raised to the number of 1400 volumes,—that is, about 14,000 pamphlets. It would be desirable that the volumes should be purchased unbroken for some public library. Such collections are very valuable for reference. Single pamphlets, lying loose in a library, are a regular nuisance, and most troublesome, always getting in the way; but if you look for any particular pamphlet you never find it. Pamphlets, however, when formed into such a collection as this, are a very different matter, and may, as I have said, be extremely valuable, as affording to future students of history very important information on cotemporary circumstances, which is sometimes not otherwise to be obtained; and for this reason some rare and curious pamphlets have been sold for enormous prices, and are much coveted by collectors. One of the most curious historical collections of pamphlets in this kingdom is that in the British Museum, which was presented in 1763, by George III., to the library of that gigantic institution. It was made by a royalist bookseller, named George Thomson, during the Commonwealth. It consists of 2220 volumes, and contains about 34,000 pamphlets, nearly all of which refer to the civil wars, and to the affairs of the country between 1640 and 1661. To show the comparative extent of Professor More's collection by a private individual, as compared with public collections, I may note here that the Edinburgh Subscription Library is advertised to contain 600 volumes, or about 1600 pamphlets; the Signet Library contains about 5000 pamphlets; the College Library about 25,000; and the Advocates Library near 67,000 pamphlets, or 3649 volumes. In catalogues of books, such as Dr Parr's "Bibliotheca Parriana," and other celebrated sale catalogues, there is generally a pretty copious account of the rarer tracts and pamphlets contained in the collection to which the catalogue belongs. But there is a *history* of pamphlets, which is one of the most extraordinary books in the English language, published in London 1715,—a book well known to librarians and collectors. The author was Myles Davies, who seems to have been odd and eccentric to the last degree. He was very poor, and wrote for bread; very learned and of great research, but his style rambling and grotesque. The work, in six volumes, is very scarce, indeed it is esteemed amongst the rarest books in bibliography, and is entitled, Εικων *μικρο-βιβλικη*—"Sive Icon Libellorum," (what we should call in Scotch "little bookies,") or a critical history of pamphlets, &c. &c. In a long, rambling preface, he enters upon a history of pamphlets, and describes their different uses and qualities. He very coolly says in the preface:—"We need not go farther back than 2000 years *before* the creation of the world." Some Jewish rabbins having profanely asserted that heaven itself had at that time written the small volume containing the synagogue rule of their law; and he quotes Saldenus, a Dutch divine, who, in the first of forty-one erudite dissertations (Amsterdam, 1684), combats the rabbinical opinion, that Adam and each of the patriarchs had written a pamphlet. Davies dedicates the sixth volume of his history of pamphlets to his patron, Dr Crowe, and addresses him in this complimentary strain in a Latin poem, commencing,—

"O corve, corvo rarior albido!"

In all the intercourse of private life, and all domestic and social relations, nothing could be more exemplary than the conduct and demeanour of Professor More. There was a gentleness of disposition which seemed to shrink from doing an unkind action, or saying a harsh word to any human being. He had that large-hearted feeling for mankind which could not withhold from others the mercy he expected for himself, and which would never deny encouragement to the most erring when making promises of amendment. I recollect his saying, with a charming simplicity of character, that he thought people were quite right to attend the lectures which Lolla Montes was delivering here at the time, as they proved that now she designed to turn over a new leaf, and to earn an honest livelihood! I have spoken of the pains which he took with his class. He was forbearing and patient with those who were idle or inconsiderate. When thoughtless or ungenerous members of the class would (as young men sometimes will) forget themselves, and take those liberties which are so unbecoming in the gentleman and the student, the kind-hearted teacher hardly gave indication that they were even noticed by him. He might be occasionally grieved or pained, but was never irritated. I have often thought it is good to have known such characters as John Schank More,—not, mark me, on account of great accomplishments, high genius, or profound learning, but because they put one in better humour with the world, and make one think better of human nature, as living illustrations of the great and pure principle of Christian love, and as exhibiting in their lives and dispositions a rare resemblance to the spirit of Him whose name we all bear. Let such men be held in honour by their cotemporaries, and let their survivors cherish their names with grateful remembrance, as true benefactors of their species, who have shown to the world, in characters which cannot be mistaken, the power and beauty of Christian gentleness.

Sir James Miles Riddell, Bart. of Strontian and Ardnamurchan, who died 28th September 1861, at the age of seventy-four, was long a Fellow of the Society, and at one time took much interest in its proceedings. He was beloved and esteemed by all his friends as a man of most amiable disposition, and honourable character, through life. Although Sir James could not be called a scientific man, in so far as special study of any branch of natural science was concerned, yet his name is associated, as a landed proprietor of Scotland, with an important mineralogical discovery. One of the earths was found on his property from which it is named, and as this mineral was first discovered by a Scotchman, and from the beginning has borne a Scottish name, I may perhaps be allowed to say a few words on the subject in passing. In 1787 some minerals were brought to Edinburgh by a dealer from Strontian, Sir James Riddell's property in Argyleshire. They were examined by Dr Hope, then the eminent Professor of Chemistry in the University. In 1791, Dr Hope announced, in a paper read to the Society, that in one of these minerals he had detected a new earth, and which he proposed to name Strontites, from the locality from whence it was received. It seems previously to have been confounded with barytes, and supposed to be some modification of that substance. The paper was more fully elaborated, and published in the "Society's Transactions" 1793. The German chemist, Klaproth, had also examined the Strontian mineral, and without any knowledge of Dr Hope's experiment, had also discovered in it the new earth, and called it "Strontion." According to our present nomenclature, the earth is called Strontia—the metal which forms the basis of the earth is Strontium, and was separated and exhibited by Sir Humphrey Davy. The native mineral from Strontian which produced the earth is called Strontianite, and is a carbonate of Strontia. It has been found also at Braundsdorf in Saxony, and elsewhere. There are other native minerals of which Strontia forms the basis, one called Celestine, so named from the beautiful blue tinge of its crystals. I have seen lovely specimens of Celestine from the Mountain Limestone quarries near Bristol. Finer specimens are, however, met with in the sulphur mines of Sicily, and still finer in the Strontian island in Lake Erie. When it was known that a new earth had been discovered in the Strontian district, the proprietor and all concerned were full of expectations of benefits which might accrue from the discovery of a substance of which they were supposed to possess a monopoly. But, alas! no use has been found for it in the arts or manufactures—none at least of what may be called particularly beneficial. The only application has been in the form of nitrate of strontia, and which is made use of to produce that beautiful red light which is exhibited in fire works, and also in certain pantomimic and melodramatic effects in theatrical representations, which delight the children who attend, both young and old.

Dr James Robertson, was born in 1803, at Ardlaw, in the parish of Old Pitsligo. His father a farmer at Ardlaw, still survives at the advanced age of eighty-six. Dr Robertson completed his education at Marischal College, Aberdeen, and his first appointment in life was to the parochial school of his native place. He was soon after appointed head-master of Gordon's Hospital in Aberdeen. In 1832 he was appointed to the living of Ellon, in the gift of the Earl of Aberdeen, and was long familiarly known, as a powerful debater in the General Assembly, as Robertson of Ellon. In 1843 he was called to the Chair of Church History in the University of Edinburgh, and Secretaryship of the Bible Board, and which situations he held till his death, which took place unexpectedly, and after a very short illness, 2d December 1860. Dr Robertson was a man of acute mind and sound judgment, a fluent speaker, and of energy indomitable. I have always considered Dr Robertson an admirable specimen of the acute, clear-headed, business-like Scottish character. His pursuits and labours were all of a useful and practical character. The conduct of ecclesiastical affairs of the Church, general parochial management, the study of Church History for his lectures—everything connected with the poor and administration of the poor-laws, agricultural improvement of soils, and the currency question, were subjects closely and skilfully investigated by him. When parochial schoolmaster, he wrote a pamphlet "On the Currency," which attracted the attention of Lord Aberdeen, and which, in fact, led to his appointing him to the incumbency of the living of Ellon. There existed through their lives a friendship and sincere mutual regard, and these continued to their deaths, which happened within a few days of each other. Dr Robertson died on 2d December, Lord Aberdeen died on the 14th, 1860.

Dr Robertson was through life much interested in the currency question, and read a very elaborate paper on the subject, at Glasgow, during the meeting of the Association for the Advancement of Social Science, which was held in that city during last year. Some time before this I was much interested in hearing him brought out upon this question, on the occasion of his dining with me, when he met my dear friend, the late Alexander Blair of the Bank of Scotland, a man of highly cultivated mind, and of great attainments in theology, in classical and general literature—the first authority in Scotland upon banking, upon the currency, and indeed upon every subject connected with finance and the circulating medium. It was very amusing to hear the discussion between two such men—one all theory, the other bringing every theory to practice; the one arguing from the conclusions of an acute intellect, the other, from long and accurate experience of banking, and of everything belonging to it, and who well knew that every opinion in money matters, however ingeniously supported, must be brought to the test of experience in the working of it under all the circumstances of the social and monetary system.

The memory of Dr Robertson will ever be preserved in Scotland as connected with that great scheme of church extension with which his name is now always associated, and which owed so much of its success to his labours and his wisdom. The intention of the scheme is to create and endow above sixty new parishes in connection with the Established Church. He was mainly instrumental in raising, by immediate or by deferred payments, for this great object, a sum of nearly half a million; and on this portion of his life I am anxious to say a few words, and I do so not only because it called forth a marked feature of his own character, and because it indicated a special power of his own mind, but because I conceive it affords a most useful *general* lesson, and supplies an honourable example for all men who are engaged in practical work, and who have to aid in plans of advancing the interests of religion, of charity, or of any improvement in social life. I refer to his labours as secretary, or convener, in which he practically advanced the details of that object of which I have made mention. The scheme was most important, and in every way praiseworthy. It called upon the members of the Established Church to join in a great and well-organised scheme for church extension. I need not dwell upon the particular constitution of the plan, the special object it placed before the community, or the special means it had in view for attaining those objects. What I wish now mainly to notice is the manner in which our late member worked the machinery of the scheme,—the diligence he displayed—the cool, yet earnest decision with which that diligence was accompanied. I would refer to his clear and powerful statements of the case he advocated; I would point to his never-failing attendance at meetings throughout the country, his constant readiness to avail himself of all advantages, to meet all deficiencies, and to correct all mistakes. His labours never seemed to be at rest; his sagacity was never at fault. It was such qualities advanced into full action that, under the favour of God's approval, brought the scheme to its present condition of efficiency, and opened its prospect of ultimate success. What I would mark out and recommend for approval and imitation, are those very exertions by which the efficiency of the scheme was promoted. Dr Robertson was a man of business, and such men are wanted amongst us,—wanted because they are scarce, and wanted because they are valuable. In vain will you have men of learning, eloquence, or acuteness upon your committees in great associations for advancing good purposes: if you have not men of *business*, the schemes will fall to the ground, or languish and decay. *Experto crede.* I have some little experience of such matters myself. Committees meet and questions are discussed, and faults are found, and measures proposed and adopted, and a great deal of acuteness and eloquence are displayed,—sometimes, perhaps, a little temper and vituperation. The committee separate, the matter sleeps, and, except some one takes it up vigorously to work it out in detail, the committee, at next meeting, find matters much in the same position as they were when they last parted. Now, all this *intermediate* labour was supplied by Dr Robertson; he set himself to the work,—he would not permit the matter to sleep,—he pushed forward the scheme,—and to the last moment of his being able to hold the plough, did not look back from his good work. He determined that his countrymen should support his scheme; and the call of the Roman poet to the Roman people in many ways typified the call of the Scottish divine to the Scottish landowner, or wealthy merchant, "Delicta majorum immeritus lues, *donec templa refeceris.*"

Such was Dr Robertson. A man of the best intellectual and active habits, who brought his understanding and his activity to bear successfully on a great and noble scheme of national benefit. He was cut off at a comparatively early age, at least whilst still capable of much useful labour; but he was followed to the grave with the respect and honour of all his countrymen, whatever were their political opinions, whatever were their religious creed.

One name only remains on our list of deceased members, that of Erskine Douglas Sandford, advocate, and Sheriff of the Stewartry of Kirkcudbright and County of Galloway. He was born in 1793. He was eldest son of Dr Daniel Sandford in the Scottish Episcopal Church, Bishop of Edinburgh. Bishop Sandford was from an old family of Shropshire. But he formed a Scottish connection by marriage. Erskine Sandford was born in Edinburgh. He had become completely in feeling and connections a Scotchman, and at one time was in good practice and high reputation as an advocate, and a writer upon law. It encroaches, perhaps, too much on the offices of private friendship for *me* to say much upon the character of this our late Fellow. But I may appeal to the *general* feeling that pervaded the circle of Edinburgh society when the unexpected intelligence came of his death; every testimony was given to his character, as a man and as a Christian, and every sympathy shown to his family in the loss which by his death they had sustained.

Gentlemen,—I have now accomplished, however imperfectly, the objects which I had before me in this Address,—viz., 1st, To notice the influence exercised generally by learned associations upon the advancement and extension of literature and natural science; and, 2d, To take a brief notice of certain members of the Royal Society of Edinburgh who have died since the opening of the late Session.

Nothing more forcibly brings before us the advancement of mankind in mental improvement and in mechanical refinement than the power which we possess of realising the past, and of storing up the discoveries and the disquisitions which have been made by those who have preceded us. Human knowledge seems now to be all recorded for the benefit of posterity. There is such a multiplication of books, and such economy in the production of books, as to make that knowledge available to all ranks of society. There is an arrangement and classification of books according to the subjects of which they treat which prevent libraries becoming a hopeless labyrinth—an overwhelming incubus. The achievements of able and original minds are preserved by those who have possessed kindred spirits with their own, and none of their labours need be lost,—nothing that they have accomplished need perish. I think our scientific societies have had a great and extensive influence in producing these results. That spirit of combination and companionship which has worked such numerous and permanent effects in all departments of human life, and which is an innate principle of human nature, has operated in combining men for objects which may be good or may be bad. Whilst we see with pain and grief the union of human beings accomplished for the express *purpose* of evil, and for injuring others in order to promote the advantage of those who unite, it is delightful to think how close, also, combinations may be made for the improvement of the species, for advancing knowledge, either exclusively in one of its departments, or generally in every department. Men combine together in associations for amusement, for recreation, or for gaiety. They combine together for purposes of pecuniary profit, to secure political ascendancy, or more refined educational benefits for their families. This spirit of combination has produced also many associations like our own; around the labours and the operations of these there has gathered an accumulated history of genius and discovery, which must be enduring as the human species itself. The highest place in our veneration and esteem is, no doubt, due to those sacred associations which are formed under a religious spirit of union, either for disseminating the Word of God in all the languages spoken by the numerous families of human beings throughout the world, or for promoting the spread of Christian knowledge, whether amongst the neglected outcasts of our home population, or amongst the heathen who have never heard a Saviour's name. But *next* to these we may venerate and esteem the associations which unite men for the cause of sound philosophy, and for advancing all branches of useful human learning, which draw men together for literary and scientific purposes, and which impart to them a common interest in the discovery and extension of truth. We cannot fail to perceive the merit of associations which thus unite men of very different habits and occupations in the encouragement of all those pursuits which, as long experience has now proved, tend to ennoble man's nature, and to elevate his sources of enjoyment.

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Report of the British Association. 1860. 8vo.—*From the Assoc.*

Journal of the Society of Arts. Weekly.

Comptes Rendus. Hebdomadaires des Séances de l'Academie des Sciences. Weekly.

Rogers on Parallel Roads of Lochaber.—*From the Author.*

Admiralty Charts.—*From the Admiralty.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. IV. 1861–62. No. 57.

Monday, 6th January 1862.

The HON. LORD NEAVES, V.P., in the Chair.

An address of condolence to Her Majesty, on account of the death of his Royal Highness the Prince Consort, was adopted by the Society; and the Secretary was directed to transmit it, after receiving the signature of the President, to Sir George Grey, Principal Secretary of State for the Home Department.

The following Communications were read:—

1. On the Climate of Palestine in Modern compared to Ancient Times. By Principal Forbes.

In this paper the writer proposes to revise and extend the argument used thirty years ago by the late Professor Schouw of Copenhagen, as to the climate of Palestine, founded on the coincident cultivation of the Date Palm, and the Vine: the one plant nearly ceasing to bring its fruit to maturity when the other begins to be productive. Tropical heat is as necessary to the maturity of the date as it is injurious to the manufacture of wine.

In Schouw's ingenious paper (Edinburgh Journal of Science for 1828), by a strange oversight, the great range of temperature of Judæa and of Palestine generally, due to the mountainous nature of the country, and to the anomalous depression of the valley of the Jordan,* was left out of account; and hence the force of the argument for the uniformity of ancient and modern climates

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* The latter fact was in 1828 imperfectly ascertained.

was materially weakened. The present writer takes these circumstances into account. He farther uses the information with which modern travellers have furnished us as to the physical and botanical geography of Palestine, including the data obtained from thermometric registers at Jerusalem and elsewhere; and he arrives at the following conclusions:—

1. That judging from the known thermometric conditions of the growth and maturity of the date palm, compared with the evidences in Scripture of its distribution and culture in Ancient Palestine, the mean temperature of the site of Jerusalem, when reduced to the level of the sea, can have then differed but little from 70° Fahrenheit, which is its present value according to the best authorities. We conclude, with still more certainty, that the temperature could not, anciently, have been *colder* than this.

2. That comparing the conditions which limit the cultivation of the vine, we find that as it certainly was not anciently less, but *more* general and advantageous than at present, the climate of Palestine could not have been materially *hotter* than now belongs to its geographical position, taking also into account the modifying influence of height above the sea.

3. That this argument is enhanced by the evidence from hieroglyphics, and also from Scripture, that the cultivation of the grape was anciently more extensive in Egypt than it now is. That while this might seem to point to the conclusion that these countries are *hotter* now than formerly, the difference is sufficiently accounted for by political circumstances, and the conclusion is itself negatived by the evidence to the contrary derived from the date palm.

4. Hence the climate of Palestine, being neither sensibly hotter nor colder than it anciently was, is of course unchanged; and the direct evidence of modern travellers on the distribution of the vine and palm in that country leads to the same result.

2. Biographical Notice of Andrew Dalzel, Professor of Greek in the University of Edinburgh. By Professor Innes.

Professor Dalzel was born in 1742, at Gateside of Newliston. His father died while he was still an infant, and he was educated partly by his uncle, the minister of Stonykirk, in Galloway, and after *his* death, by his mother, at Newliston. He attended the parish school of Kirkliston, and from thence went to college at Edinburgh. His companion at both was Robert Liston, afterwards Sir Robert, the ambassador. The boys began life together. Liston was just two days younger than his friend, and the intimacy of school and college lasted through life. It is chiefly from the correspondence kept up between them from 1766 till 1805 that the present Memoir has been compiled.

On leaving college, Dalzel was for some time tutor in the family of Lauderdale, and the friendship so commenced also remained firm and unbroken through life.

In 1772–73, partly by an arrangement with his predecessor, partly through the influence of the Lauderdales with the Town Council, Dalzel became Professor of Greek in the University. The study of that language had fallen much into decay in Scotland, and Dalzel set himself zealously to the task of restoring and promoting it. He devoted himself to the duties of his class, and was soon rewarded by its increase in numbers and improvement in study. Among other means for his object, he set about preparing some class-books for Greek students which were then unknown. His first publication was a little supplement to Moor's Grammar, under the title of *Fragmenta Grammatices Græcæ in usum tironum in literis Græcis in Academia Edinensi.* The prose volume of his well-known *Collectanea Majora* was published in 1785, and got almost at once into favour with the best teachers here and in England.

In the immediate duties of his professorship Dalzel was indefatigable. Dr Monro said of him, that "he had more to brag of than any man in the college, for that Greek was going fast downhill till he revived it." His second volume, the poetical portion of the *Collectanea Majora*, cost him great labour, and obtained the assistance of many friends among the best scholars of England. Though long promised and urgently called for by the schoolmasters and "the trade," it was not published till 1797. It was then received with as much favour as its predecessor; and the two volumes rapidly came to supersede all other class-books for Greek students. Both volumes passed through many editions, and perhaps wanted nothing for permanent success and popularity, but that the valuable information conveyed in the notes should have been given in English instead of Latin, which the practice of the time seemed to require.

Dalzel married, in 1786, Anne, daughter of Dr John Drysdale, the well known clerk of the General Assembly, and one of the leaders of the Church. His marriage connected him with the Adams, Principal Robertson, the Kennedys of Dunure, the Broughams, Elliots of Minto, and the rest of that remarkable group of Edinburgh families. His professorial position brought him into intimate acquaintance with the philosophers and scholars who then made our University famous. His labours in publishing books for his class, connected him with many distinguished scholars; and a good deal of his correspondence is preserved and used for this Memoir. It embraces letters from Heyne, Böttiger, Porson, Parr, Bishop Burgess, Dr Raine of the Charterhouse, Tate, the excellent master of Richmond school, Thomas Young, the scientific philosopher and universal scholar.

The Memoir has frequent notices of the commencement and progress of the University buildings, and other academic matters; including the first *Symposium Academicum*, the death and character of Principal Robertson, the commencement of the Society of Antiquaries, and in connection with it, the foundation of the Royal Society, of which Dalzel was an original and active member. It notices also some passing events; such as visits of remarkable persons to Edinburgh, the impression made by Burke, by Burns, by Mrs Siddons, &c.

But the chief object of the Memoir, as of Dalzel's whole life, is the restoration of Greek and classical education in Scotland. The writer gives his reasons for preferring a classical discipline to either a purely metaphysical or a merely physical course of education, formerly and now preferred among us.

Dalzel's character was singularly amiable. Living in factious and contentious times, in a society not always peaceful, he courageously avoided all quarrels, and gave his whole energy to his duty. In society and his family he was equally fortunate and beloved; and his life is an example of happiness uninterrupted, arising from successful devotion of talents to a worthy object. Dalzel died on the 8th December 1806.

The following Gentlemen were admitted Fellows of the Society:—

Henry Cheyne, Esq., W.S.
Rev. W. G. Blaikie, M.A.

The following Donations to the Library were announced:—

Annales Hydrographiques. Tome VI.—VIII. 8vo.—*From the Depôt de la Marine.*

Instructions Nautiques sur les Mers de l'Inde. Par J. Horsburgh. Tome III., 2nd partie. 1860. 4to.—*From the same.*

Mer du Nord, Troisième partie. Côtes Est d'Angleterre. 1860. —*From the same.*

Description Hydrographique des Côtes Septentrionales de la Russie. Par M. Reineke. Première partie. Mer Blanche. 8vo. 1860. —*From the same.*

Catalogue par Ordre Geographique des Cartes, Plans, Vues de Côtes, Memoires, Instructions Nautiques, &c., qui composent l'Hydrographie Française. 8vo. 1860.—*From the same.*

Catalogue Chronologique des Cartes, Plans, Vues de Côtes, &c.—8vo. 1860.—*From the same.*

Renseignements Hydrographiques sur la Mer de Chine, la Coree, la Mer et les Iles du Japon. 8vo. 1860.—*From the same.*

Instructions Nautiques sur les Traverses d'Aller et de Retour de la Manche à Java. 4to. 1861.—*From the same.*

Detroit de Banka. Nouvelle Passe pour donner dans le Detroit en venant du Sud. 8vo. 1860.—*From the same.*

Influence des Courants sur la Navigation a la Côte Occidentale d'Afrique. Par M. Vallon. 8vo. 1860.—*From the same.*

Description des Basses et des Dangers, qui sont près de la Còte S.E. de l'Ile de Ceylan. 8vo. 1861.—*From the same.*

Notice sur la Carte des Environs de Cherbourg. Par M. Keller. 8vo. 1861.—*From the same.*

Note sur l'Evaluation des Distances en Mer. Par M. de la Roche-Poncie. 8vo. 1860.—*From the same.*

Annuaire des Marées des Côtes de France, pour l'An 1861. Par MM. Chazallon et Gausin. 12mo.—*From the same.*

French Admiralty Charts.—*From the same.*

Norges Mynter i middelalderen samlede og beskrevne. Af c. I. Schive. Parts 1–3.—*From the Royal University of Christiania.*

Fortællinger om Keiser Karl Magnus og Hans Jævninger I Norsk bearbeidelse fra det trettende aarhundrede udgivet af C. R. Unger I. 8vo. Christiania. 1860.—*From the same.*

Forhandlinger i videnskabs-selskabet. Christiania. 1860. 8vo.—*From the same.*

Det Kongelige Norske Frederiks Universitets Stiftelse, &c., af M. J. Monrad. 8vo. Christiania. 1861.—*From the same.*

Oversight af Norges Echinodermer. Ved Dr Michael Sars. Christiania. 1861. 8vo.—*From the same.*

Nyt Magazin for Naturvidenskaberne. Hefte III., IV. 1861.—*From the same.*

Norske Plantenavne. Af J. Hafen. 8vo. 1860.—*From the same.*

Notice sur la Saga de Charlemagne. 8vo.—*From the same.*

Om Cirklers Berqring. Af C. M. Guldberg. 4to. 1861.—*From the same.*

Om Kometbanernes indbyrdes Beliggenhed. Af H. Mohn. 4to. 1861.—*From the same.*

Om Siphonodentalium Vitreum en ny slægt og art af dentalidernes Familie. Af Dr Michael Sars. 4to. 1861.—*From the same.*

Index Scholarum in Universitate regia Fredericiana, 1861. 4to.—*From the same.*

Solennia Academica Universitatis Literariæ Regiæ Fredericianæ. 4to. 1861.—*From the same.*

Cantate ved Det Norske Universitets Halvhnndredaarsfest. 4to. 1861.—*From the same.*

Thirty-Fourth Annual Report of the Royal Scottish Academy. 8vo. —*From the Academy.*

Proceedings of the Royal Horticultural Society, No. XXXI. 8vo. —*From the Society.*

Observations and Experiments on the Carcinus Mœnas. By W. Carmichael M'Intosh, M.D. 8vo. 1861.—*From the Author.*

Journal of the Statistical Society of London. Vol. XXIV., Part 4. 8vo.—*From the Society.*

Sitzungsberichte der Königl. Bayer. Akademie der Wissenschaften zu München. 1861. Heft IV. 8vo.—*From the Academy.*

Mémorie della Reale Accademia della Scienze di Torino. Tomo XIX. 1861. 4to.—*From the Academy.*

Nova Acta Regiae Societatis Scientiarum Upsaliensis. Vol. III. 1861. 4to.—*From the Society.*

Arsskrift utgifven af Konigl. Vetenskaps-Societetem i Upsala argangen II. 8vo.—*From the same.*

Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Tome XVI., Part 1.—*From the Society.*

Atti dell' Imp.-Reg. Istituto Veneto di Scienze, Littere ed Arti. Vol. VI. Parts 7–9. 8vo.—*From the Institute.*

Arc du Meridien de 25° 20′ entre le Danube et la Mer Glaciale. Tome I., II. 4to. With an Atlas.—*From the Royal Academy of Sciences, St Petersburg.*

Mémoires de l'Académie Imp. des Sciences de St Petersbourg. Tome IV., No. 1. 4to.—*From the same.*

Tabulæ Quantitatum Berselianarum. 1840–1846. 8vo.—*From the same.*

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Math.-Nat. Classe. B. XLII., No. 29; B. XLIII., Heft 3–5; B. XLIV., Heft 1, 2.—Phil.-Hist. Classe. B. XXXVI., Heft 3; B. XXXVII., Heft 1–4. 8vo. Wien.—*From the Academy.*

Denkschriften der Kaiserlichen Akadémie der Wissenschaften. Phil.-Hist. Classe. B. XI. 4to.—*From the same.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt. B. XI. 8vo.—*From the same.*

Almanach der Kaiserlichen Akademie der Wissenschaften. Wien. 1861. 8vo.—*From the same.*

Annales de l'Observatoire Physique Central de Russie. Année 1858. Nos. 1, 2. 4to.—*From the Observatory of St Petersburg.*

Compte Rendu Annuel. 1859–60. 4to.—*From the same.*

Beobachtungen und Elemente des Cometen. II. 1860. Von. O. Struve. 8vo.—*From the Author.*

Bemerkungen über den dritten Cometen von 1860. Von Dr A. Winnecke. 8vo.—*From the Author.*

Uber einen vom Gen. Schubert an die Akademie gerichteten Antrag, betreffend die Russ-Scand. Meridian-Gradmessung. Von O. Struve. 8vo.—*From the Author.*

Abstracts of Spirit-Levelling in Scotland. By Col. Sir Henry James. 1861. 4to.—*From the Ordnance Survey.*

American Journal of Science and Arts. No. 96. 8vo.—*From the Editors.*

Report of the Topographical and Geographical Exploration of the Western Districts of the Nelson Province, New Zealand. 8vo. 1861.—*From the Provincial Secretary's Office, Nelson.*

Proceedings of the Academy of Natural Sciences, Philadelphia. 8vo. —*From the Academy.*

Quarterly Journal of the Geological Society. No. 68. 8vo.—*From the Society.*

Abstracts of the Geological Society of London. No. 72. 8vo.—*From the Society.*

Monthly Notice of the Royal Astronomical Society. November 1861. 8vo.—*From the Society.*

Monthly Returns of Births, Deaths, and Marriages. November 1861. 8vo.—*From the Registrar-General.*

On the Concrete used in the late Extension of the London Docks. By George Robertson, C.E. 8vo.—*From the Author.*

An Investigation into the Theory and Practice of Hydraulic Mortar. By George Robertson, C.E.—*From the Author.*

Monday, 20th January 1862.

JAMES T. GIBSON-CRAIG, Esq., Treasurer, in the Chair.

The following Communications were read:—

1. Note on the Phosphorescence of Beröe. By Professor Allman.

The author stated, as the results of some experiments which he had made on the phosphorescence of a species of *Beröe* (*Idyia*) which abounded during the last summer in the Firth of Forth, that the light is never emitted as long as the animal is exposed to daylight; and that withdrawal from the daylight for some time is necessary, in order to impart to the Beröe the property of phosphorescence.

A glass jar, containing several living specimens of the Beröe in sea water, was removed from the daylight into a dark room, when not the slightest indication of phosphorescence could be detected, though the animals were subjected to precisely the same kind of irritation as is found to be always followed by the emission of light during the night. But after the Beröes had remained for about twenty minutes in the dark, the phosphorescence had become as vivid as by night; the slightest irritation would call it forth, and the vibration communicated to the jar by a blow on the table where it lay, was sufficient to cause the emission of a vivid flash of beautiful greenish light.

The author was aware that a source of fallacy might exist in the want of sensitiveness in the experimenter to faint luminous impressions, immediately after exposure of his own eyes to ordinary daylight; and accordingly no conclusion was arrived at as to the absence of luminosity until the eye was rendered sufficiently sensitive by confinement for some time in the dark room.

The absence, then, of luminosity in these animals during the day, is not due alone to the phosphorescence being rendered invisible by the stronger daylight, but to the fact that no light whatever is at that time emitted by the animal.

The author also stated that the embryo, while still included within the egg, is eminently phosphorescent, and that the emission of the light is subject to exactly the same conditions as in the adult. He was of opinion that the ova and free embryos of the Beröe and other Ctenophora, are among the chief sources of the phosphorescence of the sea in our latitudes—an opinion which finds support in the immense number of ova produced by these monœcious animals, taken in connection with the countless multitudes of Ctenophora which at certain seasons of the year crowd the seas round our coasts.

2. Contributions to our Knowledge of the Structure and Development of the Beroidæ. By Professor Allman.

In this communication the author gave the results of some careful observations and dissections he had made of a species of *Beröe* (*Idyia*), obtained in abundance during the last summer in the Firth of Forth.

In the anatomy of the adult animal, several points were described which seem to have been hitherto either overlooked or imperfectly examined. In the digestive system, the author noticed the presence of two richly ciliated membranous semi-elliptical flaps, which just before the stomach terminates in the narrow neck which leads into the bifurcating funnel, spring from its walls, and extend, by their free extremities, into the neck and commencement of the funnel. The equivalents of these flaps will doubtless be found in the two lips noticed by Milne Edwards in a similar position in *Beröe Forskalii;* and the author is of opinion that they are also the homologues of the two membranous appendages described by M. Edwards, in the stomach of *Lesueuria vitrea*. He also described the peculiar rod-like cilia noticed by Agassiz, as extending over the whole of the inner surface of the stomach, but which the author finds, in the specimens examined by him, to be confined to a broad band commencing just within the mouth, the remainder of the stomach walls being covered with ordinary cilia, which are very minute except on the contracted neck, where they become long and powerful. Peculiar enigmatical bodies were described as being present in the walls of the ramified cæca which spring from the meridional canals. They are in the form of minute cushion-like discs, which are prominent upon the external surface of the cæcal tubes. The disc is depressed in the centre, and from this depression a little conical elevation projects into the surrounding tissue of the animal. The cæcal tubes are also partially invested by a peculiar layer which extends over irregular spaces of their walls. This layer has been regarded as an extension of the ovary, but the author views it as an entirely independent structure. It is composed of minute cells, and may possibly be an eliminating organ.

A highly-developed system of capillary tubes was described in detail, as constituting one of the most interesting features in the structure of *Beröe*. These tubes seem to have been noticed by Gegenbaur,* who describes a network formed by the anastomosing offsets of cells, and which, in very young individuals, represents a system of repeatedly anastomosing tubes. They seem to constitute the same structure as that which Agassiz at one time† described as muscular fibres in *Cydippe*—an opinion, however, which he subsequently retracts, preferring, in his latest works,‡ to regard them as merely the optical expression of the walls of very large cells. The author has no hesitation in maintaining that these are all delicate capillary tubes, but without true anastomosis. They are divisible into four sets, differing from one another in their deeper or more superficial position, and in the general direction of their course. He believes that they may be conveniently divided into the following sets :—

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* Studien über Organisation und systematik der Ctenophoren. Wiegmann's Archiv, 1856.

† On the Beroid Medusæ of the Shores of Massachusetts. 1860.

‡ Contributions to the Natural History of the United States of America. Vol. III. 1860.

1. Longitudinal.	3. Deep circular.
2. Superficial circular.	4. Gastro-parietal.

In the gastro-parietal set, especially, which extend from the walls of the stomach towards the external surface of the body, he had no difficulty in demonstrating a true tubular structure. Under stimulation they contract longitudinally, and become thickened transversely; and then they are plainly seen to be thick-walled tubes, whose cavity encloses a granular matter. The tubules composing the other three sets seem to be also contractile, though this property is not so apparent in them as in the gastro-parietal set. All the four sets depolarise light, and present a similar appearance under the polariscope.

To the two oval ciliated spaces, situated one at either side of the ocellus, the author gave the name of tentacular discs. The margin of each disc is marked by a double line, on whose interval is borne a series of short hollow tentacular processes, simple in young specimens, but irregularly lobed or ramified in adults, covered over their whole surface with fine actively-vibrating cilia, and containing numerous pigment cells in their walls. The double line marks the boundary of a canal which runs round the disc upon its deep surface, and into which the bases of the tentacles open, the canal ceasing to be continuous at the inner extremity of the major axis of the disc, where there is a short space destitute of tentacles. The author maintains that the cavity of the tentacles, and their common basal canal, communicate, through the bifurcations of the funnel, with the general gastro-vascular system.

Eight chord-like organs have been noticed by observers, and have been described in detail by Agassiz as extending from beneath the ocelliform body to the extremities of the eight meridional bands; but the fact has not been hitherto noticed, that where they lie upon the cushion-like body which supports the sense capsule, they coalesce two and two, so as here to be but four in number. These four chords are clothed with true vibratile cilia. The author also described two additional chords, which originate also beneath the ocellus, one at each side, exactly opposite to the tentacular discs, and thence running outwards without dividing, lose themselves in the discs. These, like the former, are clothed with vibratile cilia. The true origin of the chords he believes to be in a ganglion-like tubercle which lies immediately under the sense capsule, and between it and the cushion-like body. Contrary to the opinion of Agassiz, the author regards these chords as truly representing a nervous system.

The author described four spherical tubercles, situated two upon each side of the cushion-like body, and between it and the tentacular discs. These are the equivalents of exactly similar tubercles described by Agassiz in *Cydippe*, but not noticed by him in his description of *Idyia*.

Development.

In his account of the development of *Beröe*, the author described the ovum, after its escape from the surrounding water, as consisting of a spherical vitellus, surrounded by an external transparent and structureless shell, which is separated by a wide interval from the vitellus, the whole being at this time generally surrounded by an atmosphere of spermatozoa, which are in the form of very minute caudate corpuscles.

No trace of germinal vesicle or spot could be detected in the vitellus, which has the appearance of being composed of minute cells, and whose peripheral portion is differentiated as a somewhat denser layer. A few hours after the escape of the ovum segmentation begins, and this process goes on until the vitellus is broken up into numerous very distinct and quite free spherules, each of which is plainly a cell filled with a multitude of similar cells. The segmenting process, however, has not been going on uniformly in all the divisions, and these resulting spherules are consequently of unequal size, and represent different stages in the process. Next, successive segmentations go on with great activity in some of the spherules, while others continue unaffected by it, or present it with much less energy, and the former become broken up into a multitude of cells, by which the latter are gradually enveloped; so that the ovum now presents two very distinct portions—a central one composed of large spherical cells, and a peripheral one of much smaller cells.

Simultaneously with the completion of the peripheral layer, a large lacuna is formed among the cells in the centre of the ovum. A depression—the future mouth—next takes place upon the surface of the embryo; and this becomes deeper and deeper, until it reaches the central lacuna, into which it finally opens. At the same time, the ocelliform body, with its capsule, and the rudiments of the tentacular discs, become apparent. The refractile corpuscles of which the ocelliform body is composed, may at this time be plainly seen to be developed in the interior of delicate spherical cells. The eight meridional bands have also by this time made their appearance, and may be seen in four pairs extending from within a short distance of the ocellus, along the sides of the embryo to about one-fourth of the whole distance from the ocellus to the mouth.

The next stage observed is the differentiation of a portion of the large-celled tissue which constitutes the principal substance of the embryo, into two somewhat piriform masses, extending one on either side of the alimentary cavity, and which, simultaneously with their formation, become excavated by an extension of the large central lacuna. They thus form two large sacs appended to the central lacuna, and opening into it, and are to become the deep longitudinal gastro-vascular canals.

Nearly at the same time, two other exactly similar masses, and also containing an extension of the central lacuna, are found opposite to one another, on the two remaining sides of the alimentary cavity, so that this cavity is now surrounded by four sacs.

The two last-formed sacs now become divided, each into two, and the divisions thus produced become more and more widely separated from one another, and become superficial to the first formed sacs. We now find them in contact with the peripheral layer of the embryo, where each sac corresponds to the space occupied by a pair of meridional bands and the interval between them.

Lastly, These four sacs begin to divide, each into two, from the peripheral towards the central side, leaving one half adhering by its peripheral side to each meridional band, so that every band has now a sac to itself, and the subsequent conversion of these sacs into the eight meridional canals is easily understood.

About the same time the central lacuna has sent off its two branches, which are to open by external orifices at each side of the ocelliform body; but the author had not succeeded in satisfactorily tracing the formation of these branches.

Hitherto the embryo was confined within the shell, but in the next stage described, the young *Beröe* was free. It was about one-eighth of an inch in length; the meridional bands had extended to somewhat more than half the distance between the ocellus and the mouth. The mouth was surrounded by the circular canal, and the two deep gastro-vascular canals had opened into the latter. The circular canal probably originates in lateral branches from the distal extremity of the deep gastro-vascular canal; but the author failed in satisfactorily tracing its mode of development. Four out of the eight superficial gastro-vascular or ctenophoral canals, namely those which corresponded to the narrow sides of the digestive cavity, had also opened into the circular canal; but the other four meridional canals, though extending for some distance beyond the oral extremities of the meridional bands, had not yet opened into it, and terminated towards the mouth, each in a blind extremity. The eight meridional canals had begun to send out their cæcal offsets; but these were as yet few in number, and simple. Individuals of about three-fourths of an inch in length had all the gastro-vascular canals in communication with the circular canal. The cæca had become numerous and ramified, and the capillary tubes appeared fully developed. The meridional bands, however, had not yet attained their full extent, their oral termination being still separated from the mouth by a distance equal to about one-third of the entire meridional length of the animal; while the generative organs had not yet made their appearance, and the processes of the tentacular discs were nearly simple.

3. On the Anatomy and Classification of the Heteropoda. By John Denis Macdonald, Esq., R.N., F.R.S., Surgeon of H.M.S. "Icarus." Communicated by Dr Douglas Maclagan.

The author considers the usual division of the Heteropoda into the two families of Firolidæ, and Atlantidæ as unsatisfactory, and arranges them in three families, according to the following zoological characters.

HETEROPODA.

I. Gymnosomata (*Firolidæ*). Animal wholly naked or without a shell.

1. With slender tentacula, and destitute of true branchiæ. Visceral mass near the root of the filiform process of the Metapodium—*Firoloides*.
2. With rudimentary or no tentacula, but furnished with true branchiæ. Visceral mass considerably in advance of the base of the filiform process of the Metapodium—*Firola*.

II. THECOSOMATA INOPERCULATA (*Carinaridæ*). Animal in great part naked, but having the visceral mass protected by a shell.

1. Shell corneous, with an involute nucleus. Swimming-plate nearly opposite the visceral mass. Metapodium with filiform appendage—*Cardiapoda*.
2. Shell calcareous with spiral nucleus. Swimming-plate considerably in advance of the visceral mass. Metapodium laterally compressed without filiform appendage—*Carinaria*.

III. THECOSOMATA OPERCULATA (*Atlantidæ*.)

1. Shell corneous with an involute nucleus. Operculum subtrigonal, with small lateral subapical nucleus—*Oxygyrus*.
2. Shell calcareous with a spiral nucleus. Operculum oval, with a large median subapical nucleus—*Atlanta*.

After describing the several characters of the order as regards external configuration, eyes, and auditory sacs, the author called attention to the rachidian teeth as being capable of furnishing good generic characters, for which they are especially valuable, as they often outlive the decay of the soft parts.

To avoid undue extension of his paper, the author selected for special description the genera Firoloides and Atlanta, which occupy, according to his views, the two extremes of the group; and he described in detail, and illustrated by coloured drawings, the anatomy of a species of Firoloides which he had met with in Bass's Strait, and the anatomy of Atlanta, with reference to all the species of the genus, adding to these some observations on the other genera, and deferring questions of specific determination to a future paper.

4. On the Structure of *Chondracanthus Lophii;* with Observations on its Larval Form. By William Turner, M.B., and H. S. Wilson, M.D., Demonstrators of Anatomy.

The authors, after a brief historical introduction, proceeded to give a detailed account of the anatomy of this parasitic crustacean, the description comprising that of the female and male, and, so far as they had been enabled to trace it, of the larva also.

FEMALE.—Average length, ½ inch; breadth, ⅛th inch—divided into cephalic, thoracic, and abdominal portions. Cephalic part presented on each side a lateral process; at the anterior margin a pair of antennæ; and on the ventral aspect a pair of hook organs and three pairs of foot-jaws. The antennæ were segmented, the terminal segments being provided with hairs. Each hook organ consisted of a basal segment and a terminal hook; the former of which was supported on a well-marked triangular frame, on which it was moved by the action of powerful muscles. The foot jaws, attached a little on one side of the mesial line, consisted of three pairs. The first and second foot-jaws consisted each of two segments. The terminal segment in the first foot-jaw was formed of two chitinic plates, connected by their anterior margins, but separated at their posterior margins, which were armed with teeth. The corresponding segment in the second foot-jaw consisted of but a single plate, toothed along its posterior margin. The third foot-jaw had three segments, the terminal one being destitute of teeth.

The cephalic was separated from the thoracic part by a constricted neck.

The thoracic part was characterised by its processes, seven dorsal, two ventral, and five lateral, the cavities within which communicated with the general cavity of the thorax. Its division into four segments was indicated by constrictions. The first and second segments bore each a pair of feet on their ventral aspects.

The abdominal part, very small, was divided into two segments, the anterior of which presented a pair of nipple-like projections, to one of which the male was attached. Of these the authors gave a minute description. Two genital orifices opened, one on each side of this segment. From each orifice a long string of ova, spirally twisted, depended. The ovaries consisted of a branched system of tubes, occupying the cavity of the thorax, and extending into the processes and feet. Each ovary communicated close to the genital orifice with the cement organ. The alimentary canal, axially situated, commenced at the oral aperture, which was situated immediately in front of the first pair of foot-jaws. It reached almost as far as the thoracic end of the animal. It possessed lateral dilatations, but no anus.

Male, very minute, $\frac{1}{30}$th of an inch in length, pyriform in shape. Divided into cephalic, thoracic, and abdominal parts—cephalic end broadest and largest; furnished with antennæ, hook organs, and foot-jaws. By its hook organs it was attached to one of the nipple-like projections on the body of the female, on which it was parasitic.

Hook organs and foot-jaws resembling in miniature those of the female. Thoracic part distinctly divided into four segments, the two anterior bearing each a pair of feet. No dorsal, ventral, or lateral processes. Abdominal part divided into two segments, in the proximal of which the two male genital orifices were situated. Alimentary canal in the axis of the animal, with a mouth situated as in the female, but no anus. Testicles bilateral.

Various stages in the development of the ovum, as far as the formation of a free larva, were then described; but the further stages, up to the fully developed animal, the author had no opportunity of tracing.

The following Gentleman was admitted a Fellow of the Society:—

ALEXANDER M'KENZIE EDWARDS, Esq., F.R.C.S.E.

The following Donations to the Library were announced:—

Journal of Agriculture, and Transactions of the Highland and Agricultural Society. No. 75. 8vo.—*From the Highland and Agricultural Society.*

Transactions of the Royal Scottish Society of Arts. Vol. VI. Part 1. 8vo. *From the Society.*

Journal of the Royal Asiatic Society of Great Britain and Ireland. Vol. XIX., Part 2. 8vo.—*From the Society.*

Proceedings of the Royal Horticultural Society of London. Vol. I., No. 1. 8vo.—*From the Society.*

Assurance Magazine. No. XLVI. 8vo.—*From the Society.*

Quarterly Journal of the Chemical Society. No. LVI. 8vo.—*From the Society.*

Journal of the Geological Society of Dublin. Vol. IX., Part 1. 8vo.—*From the Society.*

Report on the Survey of India for 1858–59. Fol.—*From the Survey Directors.*

Rivista da un Cittadino senza partito di cio che si é operato per la Pubblica Istruzione. 8vo. Bologna, 1861.

Monday, *3d February* 1862.

Dr CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. Investigation of an Expression for the Mean Temperature of a Stratum of Soil, in terms of the time of year. By J. D. Everett, M.A., Prof. of Mathematics, &c. in King's College, Windsor, Nova Scotia. Communicated by Prof. Tait.

In vol. xxii. of the Transactions of the Society, Prof. W. Thomson has given (after Fourier) the general solution of the problem of underground conduction, and he and Professor Everett have given methods more or less accurate of determining from observation the specific constants for any locality. These are mainly applied to the results of Principal Forbes's observations on the Calton Hill and other places near Edinburgh. (*Trans.*, vol. xvi.)

The present paper has for its object the calculation of the mean temperature of a given stratum of soil at any given time. If v be the temperature at time t, at depth x, v is known by the paper first referred to, in terms of x and t—and the object of the present paper is the easy approximate calculation of the value of the quantity $\frac{\int v dx}{\int dx}$ between any limits of depth x. The method is applied to the Calton Hill observations.

2. Notice of the Catadioptric Altitude and Azimuth Circle. By Edward Sang, Esq.

This little instrument differs from the ordinary theodolite in the means by which the direction of the object under examination is indicated.

The simplest contrivance for marking the direction of a distant object is a straight rod. This, with the very obvious improvement of studs at the ends, was the only instrument available to the ancients for astronomical observations; it is yet employed in gunnery, and even by surveyors in the plain-table and cross-staff.

The objection to the plain-sight, when it is to be applied to accurate purposes, is that the eye cannot be adapted to distinct vision for three different distances at the same time. We cannot see the notch, the *visé*, and the object aimed at, all distinctly.

The invention of the telescope effected a complete change in the apparatus for the precise measurement of angles. By it the arrangement of the plain-sight was reversed; the eye-hole was expanded to admit the object-glass, and the image was received at the plane of the cross-wires.

These two are the only improvements which have hitherto been made in the art of pointing. Hadley's quadrant, the invention of which has almost created nautical astronomy, is a contrivance for indicating the difference between the directions of two objects; it does not show the direction of either.

The pointer used in the catadioptric theodolite is thus the third of its class; it contains, literally within the compass of a nut-shell, the means of determining the direction of an object true to within half a minute of a degree.

About the years 1815, 1816, the late Rev. Edward Irving gave to his class of young geometers as an exercise, "To construct graduated squares with plummets attached, by help of which the tangents of angles of elevation may be observed." Some of us used pasteboard, some wood; and it happened that, having broken my school slate, which was a thick one, the idea came into my head to make my square out of the larger fragment. Armed with these little instruments, we attacked and carried most of the surrounding heights. The weather-cock on the top of the church steeple was, as a matter of course, one of our targets. On bringing the upper edge of my slate-square to bear upon it, that upper edge having been ground flat and pretty well smoothed, I saw the inverted image of the weather-cock. It then occurred to me that, if I could bring the image to agree with the weather-cock itself, the plane of the upper edge would be accurately pointed. At the same time it was obvious that when the plane passed through the object there could be no reflection.

Here, then, was a problem "To obtain a reflection such that the reflected can be collated with the direct image, and afford a test of accurate pointing." The pointer used in the catadioptric theodolite exhibits a complete solution of this problem. It is a piece of glass cut in the form of an isosceles tetrahedron, of which two faces form an edge of about 90°, the other two an edge of about 126°, the one pair being set symmetrically upon the other. This pointer has been patented. On turning it towards any object, and looking into the glass, we perceive an inverted image of the object, and on bringing the eye to look past the edge of the glass, as when using the *camera lucida*, we see the object also; and so can collate the image with the object.

By means of the motions in altitude and azimuth we can cause the image to agree with the object, and are then certain that the line of direction passes through the object.

I do not wish to occupy the time of the Society with a disquisition on the theory of the pointer, but rather to indicate the peculiar facilities which it gives for astronomical and geodetical operations in which a precision to half a minute is sufficient. The instrument is inapplicable whenever greater nicety than this is requisite.

When we point the telescope of a common surveying theodolite to a star, we find that the cross-wires have disappeared in the darkness, and that it is necessary to render the wires visible by making an artificial twilight within the tube. To hold the lamp for this purpose is so troublesome, unless—as in the case of large instruments—a special arrangement be made, that very few surveyors indeed ever use their theodolites for sidereal observations.

But, by using the crystal pointer, the star itself is made the point of reference, and the illuminating apparatus is unneeded.

If we bring the catadioptric theodolite into such a position as to cause the image of a star to agree with the star seen directly, and leave the instrument untouched, the two bright points are seen slowly to separate; while the star moves forward in its diurnal circuit the image moves with the same velocity backwards, the rate of separation is doubled, and the line joining the two points indicates the direction of the motion. In this way it is easy to determine whether the star be ascending or descending, or to judge of its being at its greatest or least altitude. Thus the determination of the latitude from the meridian altitude of a star is very easy; that of the sidereal time is not less so.

We have to note the exact instant at which some star, not far from the prime vertical, has a known altitude. For this purpose we turn the pointer a little in advance of the star, and bring the image to be very nearly above or below the star, according as the observation is made on the east or on the west side of the meridian. Then, counting the beats of the chronometer, we watch until the line joining the two become horizontal, and thus obtain the instant at which the star had the elevation shown on the altitude circle.

It is better, when making this observation for time alone, to let the image pass at a little distance—say two or three minutes—from the star, than to attempt to make them coincide, because the eye can very readily judge of the horizontality of the line joining the two luminous points. But the altitude azimuth and time can all be obtained at once in the following way:—

Having brought about the coincidence, we watch for one or two minutes, and estimate carefully the direction of the separation, then, by help of the tangent-screws, we cause the image and the star to exchange places, as it were, keeping the same inclination, and leaving the instrument untouched, we count the beats of the chronometer until the coincidence take place. In this way we obtain the time and the simultaneous readings on the altitude and azimuth circles; from these the longitude and the direction of the meridian can be computed.

The direction of the meridian is very readily obtained from the greatest easting or westing of a star which passes between the pole and the zenith, particularly in low latitudes. The manner of proceeding with the crystal pointer is to make the coincidence, to wait a little and observe the direction of separation; when this direction is vertical the star is at its greatest azimuth.

Lastly, the latitude of the place may be corrected by observing the two transits of a star over the prime vertical near to the zenith; the operation is exactly analogous to those already described.

When the horizontal axis is made perpendicular to the meridian the instrument can be used as a transit. The instant of the sun's passage can be found by observing the contact of the first limb, then the entire coincidence, and lastly, the contact of the second limb. The average of these three may, in general, be depended upon to within two seconds of time; while, by observing the moon's meridian passage, and comparing it with those of two stars, the Greenwich time may be obtained to within one minute from a single set of observations.

The lightness and portability of the instrument, and its adaptation to near or distant objects, promise to bring the practice of geodetical astronomy within the reach of many who have been hindered from the prosecution of this branch of science by the bulk and expensiveness of the instruments required.

3. On the Nesting Birds of Linlithgowshire and Berwickshire. By the Rev. John Duns, F.R.S.E., Torphichen.

In April 1860, I brought under the notice of the Society a classified list of the Birds of Linlithgowshire. The list was accompanied with notes, "On the Structure and Habits of some of the Rarer Species." After the publication of the Society's Proceedings, several communications were addressed to me by well-known ornithologists, chiefly with the view of ascertaining, if some of the rarer species named had been known to nest in the district. This led to the revision of the list, and to the exclusion of such species as are either rare visitors only, or winter birds of passage. A List of the Birds of Berwickshire, drawn up on the same plan, is now associated with this.

Were similar lists to be drawn up by observers in other counties, the true native birds of Scotland would be better known than they are at present. In most works on British Ornithology they are classed with stragglers from almost every clime.

Several influences are at work, which may soon come to diminish the numbers of our native nesting-birds, and which have already reduced them in certain districts. In the Lowlands, there are now large tracts of country, in which game is not protected, and in which laws of trespass are never enforced. It is thus easy for any youth to carry a gun in quarters in which, a few years ago, he would have been closely watched. The rarer birds suffer; they are intruded on in their favourite haunts, and either scared from them at the breeding season, or wantonly destroyed. The black grouse, which used to breed regularly in Linlithgowshire, is now seldom seen, and the red grouse is now confined to a heath-clad tract, of a few hundred acres, which is being fast broken in upon by mining operations. In the course of four or five years, both species will cease to be reckoned as nesting-birds in the county. The king-fisher, the ring-ousel, the redstart, the gold-crest wren, the bullfinch and goldfinch, have so greatly diminished within a few years, that they are now comparatively rare.

The strict preservation of game has had an influence in another direction. War is waged against every bird believed to be hurtful to the eggs or to the young of the pheasant, partridge, and grouse. The kite has disappeared from the middle and south of Scotland. In Berwickshire, the hen harrier is now rare; and in Linlithgowshire it appears at long intervals as a straggler only. The merlin will soon cease to be met with in both counties. The sparrow-hawk is fast disappearing; and even the kestrel—the farmer's friend against field mice, and several beetles, whose larvæ are most hurtful to his wheat crops—is ignorantly shot down as a plunderer, though entirely innocent touching game. In comparatively recent times, the raven used to nest in Linlithgowshire. It is now never seen. In Berwickshire, it is rare. In Linlithgowshire, the jay is seldom met with, and even the magpie is not able to cope in cunning with the gamekeeper.

Agricultural improvements are also beginning to tell unfavourably on some of our native birds. If the alternative were,—"You must either lose the green and corn crops, or destroy the birds," I suppose even the most enthusiastic naturalist would choose the latter. But it should be the chief aim of the agriculturist to keep the birds alongside of his improvements. Since by drainage, he has banished the wild duck, the curlew, and the snipe, from localities in which they used to abound, he would find it profitable to set apart a spot specially for them. And if he must have stone walls and wire fences, in order to get quit of weeds and to save his crops from insects which find shelter during winter in the hedgerows, he would never regret having left a bush here and there for the birds to build in. If this be not done, he will assuredly find in the turnip-beetles and saw-flies, in the corn-midges and wire-worms—the larvæ of weevils and elaters—"a great people and strong," enemies, any thousand of which will do more harm to his crops than all the birds of the air would.

In the following list the birds of Linlithgowshire are referred to on the left hand of the column. Those of Berwickshire are characterised on the right hand.

The letter R denotes *Regular*, or birds which breed constantly in the districts; H denotes *Historical*, or birds which used to breed in the localities, but which have for many years ceased to do so; O denotes *Occasional*, or birds which have been known to breed at long intervals in the districts ; and O, B refers to such as have been seen occasionally at the breeding season, but whose nests have not been discovered.

Linlithgowshire.		Berwickshire.
O.	Falco æsalon.	O.
R.	F. tinnunculus.	R.
R.	Accipiter nisus.	R.
H.	Circus cyaneus.	R.
R.	Strix flammea.	R.
R.	S. aluco.	R.
R.	S. otus.	R.
R.	Cuculus canorus.	R.
R.	Caprimulgus Europæus.	R.
R.	Hirundo rustica.	R.
R.	H. urbica.	R.
R.	H. riparia.	R.
R.	Cypselus murarius.	R.
O.	Alcedo ispida.	R.
R.	Certhia familiaris.	R.
R.	Troglodytes Europæus.	R.
R.	Turdus merula.	R.
O.	T. torquatus.	R.
R.	T. viscivorus.	R.
R.	T. musicus.	R.
R.	Cinclus Europæus.	R.
O.B.	Lanius excubitor.	
	L. collurio.	O. B.
R.	Sylvia rubecula.	R.
R.	S. hortensis.	R.
	S. atricapilla.	O.
R.	S. cinerea.	R.
R.	S. phœnicurus.	R.
O.	S. locustella.	
O.	S. arundinacea.	O.
O.	Phyllopneuste sylvicola.	R.
R.	Ph. trochilus.	R.
O.	Ph. hippolais.	R.
R.	Regulus auricapillus.	R.
R.	Saxicola œnanthe.	R.
R.	S. rubetra.	R.
R.	S. rubicola.	R.
R.	Accentor modularis.	R.
R.	Parus cæruleus.	R.
R.	P. major.	R.
R.	P. longecaudatus.	R.
R.	P. ater.	R.
R.	Motacilla Yarrelli.	R.
R.	M. boarula.	R.
R.	M. flava(*Budytes*.)	R.
R.	Muscicapa grisola.	R.
O.	M. luctuosa.	
H.	Corvus corax.	O.
O.	C. corone.	R.
R.	C. cornix.	R.

Linlithgowshire.		Berwickshire.
R.	Corvus frugilegus.	R.
R.	C. monedula.	R.
R.	Garrulus melanoleuca.	R.
R.	G. glandarius.	R.
R.	Sturnus vulgaris.	R.
R.	Pyrgita domestica.	R.
R.	Fringilla cælebs.	R.
O.	F. spinus.	
R.	F. carduelis.	R.
R.	F. cannabina.	R.
O.	F. linaria.	R.
	F. flavirostris.	O.
R.	Loxia chloris.	R.
R.	L. pyrrhula.	R.
O.	L. Europæa.	
R.	Emberiza citrinella.	R.
O.	E. miliaria.	R.
R.	E. shœniculus.	R.
R.	Alauda arvensis.	R.
R.	Anthus pratensis.	R.
	A. obscurus.	R.
O.	A. arboreus.	O.
R.	Columba palumbus.	R.
	C. livia.	R.
O.	Tetrao Scoticus.	R.
O.	T. tetrix.	R.
R.	Perdix cinerea.	R.
O.	P. coturnix.	
R.	Phasianus colchicus.	R.
R.	Ardea cinerea.	R.
H.	Botaurus stellaris.	
R.	Charadrius hiaticula.	R.
R.	Pluvialis aurea.	R.
	P. morinellus.	O. B.
	Hæmatopus ostralogus.	R.
O.B.	Scolopax rusticola.	
R.	S. gallinago.	R.
O.B.	S. gallinula.	
R.	Numenius arquata.	R.
R.	Totanus hypoleucus.	R.
	T. calidris.	R.
O.	Tringa variabilis.	R.
O.	Rallus aquaticus.	R.
R.	Crex pratensis.	R.
R.	Gallinula chloropus.	R.
R.	Fulica atra.	R.
R.	Cygnus mansuetus.	R.
R.	Anas domesticus.	R.
R.	A. boschas.	R.
O.B.	A. crecca.	O.

Linlithgowshire.		Berwickshire.
	Anas tadorna.	O.
O.	Podiceps minor.	R.
	Uria troile.	R.
	U. grylle.	R.
	Alca torda.	R.
	A. artica.	R.
	Pelecanus carbo.	R.
	P. graculus.	R.
	P. bassanus.	O.
	Puffinus anglorum.	O.
	Procellaria pelagica.	O.
	Larus rissa.	R.
	L. marinus.	O.
	L. fuscus.	O.
	L. argentatus.	R.
	L. canus.	R.
	L. ridibundus.	R.
	Sterna cantiaca.	R.
O.	S. hirundo.	R.
	S. artica.	R.
	S. minuta.	R.
	S. Dougalii.	O.

A pair of the grey shrikes named in the list, frequented some old thorn trees, near Torphichen village, during the end of May and beginning of June 1846.

The red-backed shrikes were observed by me in July 1859, at Oxendean, near Dunse Castle, Berwickshire. This, I believe, was the first time they have been seen in Scotland. The red-backed shrike passes the winter in Africa, and visits England in May. "It breeds," says Fleming, "in the southern counties of England." "It is," says the late Bishop of Norwich, "generally speaking, very rare in most parts, confining itself to Essex, the Sussex Downs, Wiltshire, and Gloucestershire." Mr Selby has not traced it farther north than Cumberland. M. E. T. Bennet, in one of his notes to White's Selborne, refers to this bird as one which belongs to the south of England, and is scarcely ever met with in the north. In 1840, Mr M'Gillivray recorded that "it had not hitherto been observed in Scotland."

4. Note on Molecular Arrangement in Crystals. By Professor Tait.

To illustrate my lectures on Molecular Forces, I sometimes use piles of marbles of equal size. Each of these is taken to represent the *sphere of action* of a symmetrical integrant molecule, in the sense that the attractive and repulsive forces necessary to a theory of molecules are balanced, when the distance of two molecules is equal to the diameter of the sphere. If the integrant molecules be not symmetrical, their *spheres of action* will be spheroids or ellipsoids.

In arranging such piles, there are two obvious ways of constructing the layers, and two of applying layer to layer.

Thus, a horizontal layer (suppose) may be arranged in *square*, or in *triangular* order; and successive layers may be *simply superposed* or *inserted into interstices* in the preceding ones.

By this it would appear, at first sight, that arrangements of four different densities are producible. Such, however, is not the case. The very obvious results which I intend now to give, must have occurred long ago to others, but I have found no such record; and their apparent novelty to scientific friends to whom I have mentioned them, must be my excuse for occupying the time of the Society with so trifling a matter.

The density of a mass, or the number of marbles per cubic mile (say) is easily seen to be proportional inversely to the product of the distances of the centres of contiguous ones, taken parallel to any three rectangular lines.

Hence

(1.) When layers in square order are superposed, a being the radius of a molecule—

$$\text{Density} \propto \frac{1}{2a \times 2a \times 2a} \propto \frac{1}{8a^3}.$$

(2.) Layers in triangular order superposed—

$$\text{Density} \propto \frac{1}{2a \times 2a \times \sqrt{3}a} \propto \frac{1}{4\sqrt{3}a^3}.$$

(3.) Layers in square order, interstices occupied by molecules of next layer—

$$\text{Density} \infty \frac{1}{2a \times 2a \times \sqrt{2}a} \propto \frac{1}{4\sqrt{2}a^3}.$$

(4.) Layers in triangular order, interstices as before,—

$$\text{Density} \propto \frac{1}{2a \times \sqrt{3}a \times \dfrac{2\sqrt{2}a}{\sqrt{3}}} \propto \frac{1}{4\sqrt{2}a^3}.$$

These densities are $(1.) : (2.) : (3.) : (4.) :: \frac{1}{\sqrt{2}} : \sqrt{\frac{2}{3}} : 1 : 1$; or, $\cdot707 : \cdot816 : 1 : 1$, and may be sought for in various forms of the same body.

Hence, the density in arrangements (3) and (4) is the *same*. It is worthy of note, that the simplest crystalline form which is derivable from (3), is the octahedron of the first system, and that from (4), is its *hemihedral* form, the regular tetrahedron.

By inspecting the piles of marbles for the two cases, it is easy to see without analysis, that the densities are equal. This is best seen by removing an *edge* of the tetrahedral pile.

I have tried to connect these results with allotropic forms of bodies which crystallize in the first system (and an easy modification allows us to pass to other systems)—but though diamond and graphite *seem* to agree so far with it—it must be taken at present as a pure speculation.

The following Gentlemen were admitted Fellows of the Society:—

Walter Boyd M'Kinlay, M.D., F.R.C.S.E.
Edmund Ronalds, Ph.D.
John J. Macartney, M.D.

The following Donations were received:—

Quarterly Report of the Meteorological Society of Scotland. 8vo. —*From the Society.*

Twelfth, Thirteenth, and Fourteenth Annual Reports of the Regents of the University of the State of New York, on the Condition of the State Cabinet of Natural History. 8vo.—*From the New York State Library.*

Seventy-Third and Seventy-Fourth Annual Reports of the University of the State of New York. 8vo.—*From the same.*

Forty-Second and Forty-Third Annual Reports of the Trustees of the New York State Library. 8vo.—*From the same.*

Guide to the Geology of New York, and to the State Geological Cabinet. 8vo.—*From the same.*

Magnetical and Meteorological Observations made at the Government Observatory, Bombay. 1859. 4to.—*From the India Office.*

Vis Inertiæ Victa, or Fallacies affecting Science. By James Reddie. 1862. 8vo.—*From the Author.*

Contribuciones de Colombia. Por E. Uricoechea. 1860. 8vo.—*From the Author.*

Memoire sur l'Integration des Equations Differentielles relatives au Mouvement des Cometes. Par Jean Plana. 1861. 8vo. —*From the Author.*

Proceedings of the Royal Geographical Society of London. Vol. VI., No. 1. 8vo.—*From the Society.*

Astronomical and Meteorological Observations made at the Radcliffe Observatory, Oxford, in the year 1858. Vol. XIX. 8vo.—*From the Observatory.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. IV. 1861–62. No. 58.

Monday, 17th February 1862.

PROFESSOR KELLAND, V.P., in the Chair.

The following Communications were read :—

1. On the Condition of the Salmon Fisheries of England and Wales in 1861; with a Notice of some of the Modes of Fishing, especially those practised in the Severn and Wye. By Sir William Jardine, Bart., F.R.S., &c.

The author proposed in this paper to give more detailed observations on the salmon fisheries of England and Wales than could be done in the compass of an official report, and at the same time to add notes on the natural history of the migratory species of Salmonidæ met with in these fisheries. The first part related to the Severn and Wye.

No subject has been more legislated upon than that of the regulation of the salmon fisheries of Great Britain and Ireland; and while this indicates the importance attached to them, it has been at the same time mainly caused by the want of a correct knowledge of the facts relating to them, an ignorance of the habits and natural economy of the species, and by parties looking at one or two insulated points only, instead of viewing the subject and the various interests connected with it as one.

Independently of the want of co-operation by the proprietors of rivers, and the system of killing fish at all seasons of the year, weirs put up for the purpose of driving machinery, and to which fish-traps were almost always attached, caused great injury and obstruction to the run of salmon; and the Severn had been specially injured by the erection, within a few years, of large weirs for navigation purposes, which not only prevented salmon running freely, but completely prevented access to flounders and all the smaller migratory fish which ascended for the purpose of spawning; such as shad, lamprey, lampern, &c. &c. These all yielded a considerable revenue and food for the population, and were taken 100 miles above tideway. They are all now entirely shut out.

The Severn and Wye have been for a long period, and still continue to be, fished by peculiar engines, which, in all probability, may soon be entirely done away with, or be much modified in structure; a record of these is therefore interesting. Those used in the Severn are putts and putchers, or trumpets, as the latter are termed from their shape; and they form in that river by far the most extensive salmon-fishery by means of fixed engines in any part of the English or Welsh waters.

Putchers or *trumpets* are long, conical, wicker-work baskets with a mouth two feet wide, gradually narrowing, and ending in an opening so small as to prevent a fish of moderate size passing through. This, indeed, is frequently abused, and some are made so small as to take fish of two pounds weight. The stake or framework for these engines is about thirteen or fourteen feet high, and is fixed into the shore in two parallel rows of various lengths from high-water mark seaward. These are bound together by cross bars, on which rest the *putchers*, placed one above another in rows, with the wide mouth up or down stream, as they are intended to catch fish upon the ebb or flow of the tide. The greatest number are set with the mouth up the river, or to the stream; the salmon falling down with the current enter the large mouth, and are literally jammed in the narrow end, which admits the head only, and holds the fish secure. They are thus often much injured, and rendered unseemly for the market by the scales being rubbed off in the struggles to escape, and no unclean, unseasonable, or old fish that enters can again escape or be let out alive. The tide in the Severn rises to a great perpendicular height, often exceeding twenty feet above the top of the putcher stages; and it is considered that comparatively few salmon are taken during the flow, the fish swimming near the surface, and above the mouths of the putchers, as soon as the tide rises a few feet above them. Most fish are taken in the ebb, or in the putchers with their mouths set up the river, proving without doubt that a large number of fish ascend so far and return again without ever entering the fresh-water part of the river.

The *putts* or *putt-nets*, as they are sometimes called, are placed on the same kind of stages. They are also formed of wicker or basket work, but are more complicated, and the wicker work is closer, and executed with more care. The whole machine is about twelve feet long, and consists of three parts, which can be attached to each other as occasion requires—the kipe, butt, fore-wheel or biddle. The diameter of the chief part, or kipe, is about five feet at the mouth, and fourteen inches at the lower or narrow end. The butt is fourteen inches wide at the neck and six at the lower end. These take large fish by having cross-bars placed in the narrow end; and to this can be affixed at will the third part, the *forewheel* or *biddle*, constructed somewhat like a mouse-trap inside, and used for taking everything small—shrimps, small soles, young cod, flounders, eels, lamperns, &c. In one taken off a few days before, we found shrimps, a small eel, and a rock pipit; in fact, nothing that enters the large, open, five-feet-wide mouth escapes when this fore-wheel is kept attached. The putt-net is extremely destructive to all young fish, and in spring, when the salmon fry descend, they are taken in hundreds. The fishermen, however, say that they now remove the fore-wheel during the fry season, and it is the river conservator's duty to see that this is attended to.

The Wye is a very fine stream, and has also had many persecutions. There are, however, no navigation weirs or other formidable obstructions within the first twenty or twenty-five miles of its course from the sea. One great abuse in this river is the recognised killing of the *skirling*, which is the young of the salmon, the *parr* of Scotch rivers. They are killed in thousands, and are hawked about the country for sale, and purchased by the gentry as well as by the labouring classes. Tourists come to Monmouth to eat skirling. Monmouth is in fact the Woolwich of the Wye; skirling its whitebait. The history and present position of the *parr* question is given here, and is thus summed up. "Any one who will insist now that a parr is not a young salmon, must have some warp in his intellect, not to be removed by any possible demonstration."

In the Wye, coracle nets are much used; but the peculiar mode of fishing in the Wye, Usk, and that system of rivers, is called *stopping*, or *stop-net fishing*.

At the commencement of the ebb or flow of the tide, a large boat is moored by anchor, and fixed by long sharpened iron-shod poles in what is supposed, or rather by experience is known to be, the "run of the fish." A large bag net, on a frame of from 25 to 35 feet beam, capable of being easily raised by the fishermen employed, is let out upon the side next the ebb or flow, so that the bag is carried out by the tide underneath the boat. The fisherman, with one arm, leans on the angle of the frame ready to act, and has the loop of a cord attached to the bag of the net round a finger of the other hand. The slightest interference with the net is felt by the looped finger, and when a salmon strikes the net is quickly raised, and the fish secured in the bag. At suitable states of the tide, numerous boats may be seen going out prepared to "stop," and ply their precarious fishing. The stations are taken up by turns, some being considered more certain than others, to allow the men an equal chance; for these fishings are generally sublet, the lessee of the fishery sometimes supplying boats and nets, paying the men according to the quantity of fish taken, or a certain agreed upon proportion of the price. It is a mode of fishing, however, far behind the present time and invention, and the boats and nets necessary for it must require very considerable capital. It is, moreover, uncertain, and occupies a large portion of time compared with the quantity of fish taken. There is nothing particularly injurious to the fisheries in the use of these engines if fairly employed, and any unseasonable or old fish may be easily set at liberty uninjured; at the same time, several boats are sometimes set in line, and then they form greater barriers to a clear run; but as it is only for a few hours at the flow of the tide, or after it has partially ebbed, that this kind of fishing can be practised, it can scarcely be looked upon as a serious obstruction.

2. Cases of Poisoning by Goat's Milk. By Alexander E. Mackay, M.D., Surgeon H.M.S. "Marlborough."

On 27th November 1861, eleven wardroom officers of the "Marlborough," including the author, were simultaneously attacked with extreme faintness, nausea, bilious vomiting, and diarrhœa;

the attacks lasting five or six hours—in some of the cases being of great severity, and attended with much depression. The treatment, which was successful in every instance, consisted in encouraging free vomiting, and the administration of stimulants and anodynes. At the same time a series of similar cases occurred in H.M.S. "Agamemnon," and five other ships in the harbour. The only article of food which had been taken by all those who were affected was the milk used at breakfast, and to this the poisoning was evidently to be ascribed. On inquiry amongst Maltese of all classes the author found that there is a plant known in Malta by the name of Tenhuta which is eagerly eaten by the goats, from which animals almost all the milk used by the shipping is procured, and which communicates to their milk nauseous properties. This proved to be *Euphorbia Paralias*, the common sea spurge; and its property of rendering the goat's milk poisonous is so well known, that the goats, from which milk is to be got for supplying families and public institutions in Malta, are never allowed to feed at large where they can have access to the Euphorbia. It was stated to the author that the Maltese milkmen know perfectly well when a goat has eaten the Tenhuta from the appearance of the milk, which, if poured into the hollow of the hand and spread out by the finger, shows yellowish streaks through it. A somewhat puzzling circumstance was, that all the officers who partook of the milk did not suffer, and one gentleman escaped without any seizure who had drunk a whole bottle of milk. On the other hand, of the patients in the sick bay only one was seized, and this was a man who had procured some milk for himself from shore; and one alarmingly severe case, which occurred in the "Agamemnon," was in the person of a gentleman who had breakfasted entirely on milk. The author suggests, as an explanation of the immunity of some and the severe seizures of others of the consumers of the milk, that if the poisonous property reside in the above mentioned yellowish streaks, which seem readily separable from the bulk of the milk, the unequal distribution of the poisonous matter may account for the violent symptoms in one, the milder seizures in a second, and the total absence of all symptoms in a third.

3. Note on the Electricity developed during Evaporation and during Effervescence from Chemical Action. By Professor Tait and J. A. Wanklyn, Esq.

One of Professor W. Thomson's Divided-Ring Electrometers having been recently procured for the Natural Philosophy collection in the University, we have made use of it in repeating and extending the experiments of Volta, Pouillet, and others, on the electricity produced during the evaporation of various bodies. In some cases our results agree with those already known, but in others we find effects differing totally in kind or degree from the accepted ones; and with some substances we find occasionally contradictory indications among our own results.

The Electrometer is in every respect a far superior instrument to the gold-leaf electroscope, which (sometimes with the addition of a condenser) was used by former experimenters, and enables us to give our results in a form easily reducible to absolute measure. The charge of the instrument was such that, when the half rings were respectively connected with the zinc and platinum of a single Grove's cell, the deflection observed amounted to about 5·8 scale divisions. This was found to be the most useful charge for the bulk of our experiments, but it was easily increased twenty or thirty fold when we sought to verify any very delicate indications.

Our apparatus consisted of a platinum dish, placed on an insulating stand, and connected with the insulated half ring. A lamp could be placed on the stand so as to heat the dish; and while this was going on the indications of the electrometer gave us the atmospheric charge. The experiments were all conducted when the latter was very small, so that although the sputtering of the fluids dropped on the hot plate may have prevented us from observing some slight effects, the large deflections we observed in many instances can have nothing to do with the electric state of the air of the room. With a different disposition, which enabled us to use a Bunsen lamp to heat the dish, we obtained the atmospheric potential by burning a little ether or alcohol on the dish itself, when the lamp was removed.

We agree generally with previous experimenters, that during the continuance of the spheroidal state, there is little, if any, perceptible disengagement of electricity. We also agree with the statement that the main effect is produced while the fizzing sound that accompanies the loss of the spheroidal state is heard, and that during the continuance of the mechanical action to which that sound is due, the indications of the electrometer in general steadily increase. That the greater part of the electricity produced is due to friction is proved by the fact that, when fluids are forcibly squirted upon the hot dish, the electrical indications are very much increased, and that a concave surface gives far more powerful deflections than a convex one at the same temperature. The sputtering or violent boiling which succeeds the fizzing state, shows little, if any, disengagement of electricity. The principal interest of the results which we have obtained is in the cases of iodine, bromine, and various other bodies which do not seem to have been before examined. We have as yet met with no discordance in our own results as far as *simple* bodies are concerned.

In giving the following numbers, we have not attempted any correction for the loss of electricity which is caused by the high temperature of the platinum dish.

Mean Electric Effects given by a few substances during the continuance of the fizzing sound which immediately follows the disappearance of the Spheroidal State, 5·8 representing the Electromotive Force of a Single Grove's Element.

Bromine, . . .	+ 400
Iodine, ...	+ 90*
Bromide of Ethyl, . .	+ but very small indeed, if any
Iodide of Methyl, . .	In many experiments strong +, but in three cases pretty strong −
Benzole, . . .	No effect
Valerianic Ether, . .	No effect
Common Ether, . .	Very slight and dubious effects
Chloroform, . . .	− if plate very hot, + if colder
Ammonia, . . .	− 200
Alcohol, . . .	− 10
Mercury, . . .	− 75
Chloride of Sulphur, .	− 100
Water (distilled), containing only a trace of carbonic acid, which was too small to be detected by lime-water, . . .	− 80

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* This sample was in fine crystals. Far higher effects (also positive) were obtained from it in powder.

Solutions in Water of—		
Carbonate of Potash (strong),	− 310	
Caustic Soda (strong), .	− 40	[*]
Do. (dilute), .	− 25	
Caustic Potash (combustion strength), . .	+ 150	
Nitric Acid (strong), .	+ 7·5	
Do. (1 in 4 of water),	− 35	
Hydrochloric Acid (strong),	− 160	
Do. (weak),	− 50	
Sulphuric Acid (strong),	+ 15	
Strong solution of Na Cl .	− 400	
Do. KI .	− 80	
Do. CuO,SO_3	− 1000 ?	
Solution of double Oxalate of Chromium and Potash,	Very trifling effect	
$Fe_2 Cl_3$, solution moderate,	Negative effect	
Acetic Acid (Monohydrate),	+ 3	
Acetic Anhydride, .	− 9	

The sulphate of copper solution is by far the most remarkable that we have tried. The smallest globule, on leaving the spheroidal state, gave intense effects, sending the lamp image entirely off the scale.

We have also commenced a set of experiments with a view to test the electricity developed during the brisk disengagement of a gas by chemical action, which was discovered eighty years ago by Volta. In some of these experiments it was observed that when the gases were disengaged with considerable effervescence, and in a mass of large bubbles foaming over the platinum crucible in which the experiment was conducted, the bursting of each bubble was attended by a simultaneous increase of deflection in the electrometer. These experiments are, as yet, exceedingly imperfect, but they seem, like the preceding, to indicate friction as a main cause of the observed results. The effects on the electrometer are by no means so uniform, either as to kind or quantity of electricity, as those given by evaporation.

Electricity developed during Effervescence.

$Zn + HCl$ . .	− 750
$Zn + NO_5HO$.	+ 175. In another trial − 120
$MnO_2 + HCl$ . .	− 150
$Ca\,O,CO_2 + HCl$ . .	Trifling effects
$Na\,O,SO_2 + HCl$ . .	At first a small negative deflection, finally + 50
$Na\,Cl + SO_3HO$.	+ 10

[*] This is a very difficult substance to experiment upon.

The following gentlemen were elected Ordinary Fellows:—

THOMAS C. ARCHER, Esq.
Rev. V. G. FAITHFULL.
JAMES HECTOR, M.D.

The following Donations to the Library were announced:—

Manual of Civil Engineering. By William John Macquorn Rankine. 8vo. 1862.—*From the Author.*

Proceedings of the Royal Horticultural Society. Vol. II. No. 2. 8vo.—*From the Society.*

List of the Fellows of the Royal Horticultural Society, corrected to January 1862. 8vo.— *From the Society.*

Proceedings of the Royal Society of London. Vol. XI. No. 47. 8vo.—*From the Society.*

Journal of the Chemical Society. Vol. XV. No. 1. 8vo.—*From the Society.*

Journal of the Royal Dublin Society. Nos. XX.–XXIII. 8vo.—*From the Society.*

Monthly Notices of the Royal Astronomical Society. Vol. XXII. No. 3. 8vo.—*From the Society.*

Abstracts of the Proceedings of the Geological Society of London. No. 75. 8vo.—*From the Society.*

Öfversight af Kongl. Vetenskaps-Akademiens förhandlingar. 1860. 4to.—*From the Royal Academy of Sciences, Stockholm.*

Kongliga Svenska Vetenskaps-Akademiens handlingar. 1859. 4to. —*From the same.*

Kongliga Svenska Fregatten Eugenies Resta omkring Jorden under befäl af C. A. Virgin 'aren 1851–53. Botanik Haft II., Part 2. Zoologi Haft X., Part 5. Fysik Haft VIII., Part 2. 4to.—*From the same.*

Voyage autour du monde sur la Fregate Suedoise l'Eugenie, executé pendant les années 1851–52. Physique Haft IX., Part 2.—*From the same.*

Om fisk-faunan och fiskierna i Norbottens Län Reseberattelse. Af H. Widegren, Afgifvenden 10 Mars. 1860. 8vo.—*From the same.*

Atti del Reale Istituto Lombardo di Scienze, Lettere ed Arti. Vol. II. Fasc. X.–XIV. 4to.—*From the same.*

Memorie del Reale Istituto Lombardo di Scienze Lettere ed Arti. Vol. VIII. Fasc. V. 4to.—*From the same.*

Bulletin de l'Academie Imperiale des Sciences de St Petersbourg. Tom. III. Nos. 6–8. Tome IV. Nos. 1, 2. 4to.—*From the Academy.*

Memoires de l'Academie Imperiale des Sciences de St Petersbourg. VII^{e}. Serie. Tome III. Nos. 10–12. 4to.—*From the same.*

Preisschriften gekrönt und herausgegeben von der fürstlich Jablonowskischen Gesellschaft zu Leipzig. Parts VIII. and X. 1861. 8vo.—*From the same.*

Monday, 3*d March* 1862.

Dr CHRISTISON, V.P., in the Chair.

1. On the Pressure Cavities in Topaz, Beryl, and Diamond, and their bearing on Geological Theories. By Sir David Brewster, K.H.

In this paper the author gave a brief account of the various phenomena of fluid and gaseous cavities which he had discovered in diamond, topaz, beryl, and other minerals. He described—

1. Cavities with two immiscible fluids, the most expansible of which has received the name of *Brewstolyne,* and the most dense that of *Cryptolyne,* from the American and French mineralogists.

2. Cavities containing only one of these fluids.

3. Cavities containing the two fluids, and also crystals of various primitive forms, some of which melt by heat and recrystallise in cooling.

4. Cavities containing gas and vapour.

The author stated that the first class of cavities existed in thousands, forming strata plane and curved, and intersecting one another at various angles, but having no relation to the primitive and secondary planes of the crystal. From these facts he drew the conclusion that the minerals which contained them were of igneous origin; and he considered this conclusion as demonstrated by the existence of what he calls *pressure cavities,* which are never found in crystals of aqueous origin. These microscopic cavities, which are numerous in diamond, exist also in topaz and beryl. The gas which filled them had compressed by its elastic force the substance of the mineral around the cavities, as shown by four sectors or quadrants of light which it polarises; and consequently the mineral must have been in a soft or plastic state by fusion when it thus yielded to the pressure of the included gas.

2. On the Anatomical Relations of the Surfaces of the Tentorium to the Cerebrum and Cerebellum in Man and the lower Mammals. By William Turner, M.B. (Lond.), Senior Demonstrator of Anatomy in the University of Edinburgh.

Comparative anatomists have of late directed considerable attention to the determination of the relations of the cerebrum and cerebellum. This has been in great measure due to the publication by Professor Owen of a system of classification of the Mammalia founded on their cerebral characters. The statement made by that eminent anatomist, that the posterior, or third, lobe of the cerebrum is peculiar and common to the genus Homo, and that equally peculiar are the "posterior horn of the lateral ventricle" and the "hippo-campus minor," which characterise the hind lobe, has led to much discussion. Various anatomists have published descriptions and drawings of dissections of the brains of many of the Quadrumana, especially of several of the higher apes. From these dissections, as well as from the older observations of Tiedemann and Cuvier, it may now be considered as fully proven, that in the Quadrumana the surface of the cerebellum corresponding to the superior surface of the human cerebellum is covered by the cerebrum; that posterior lobes, posterior cornua and hippocampi minores, are possessed by these animals.*

In the mammalia lower in the scale than the Quadrumana, it appears to be the general opinion of anatomists that the posterior cerebral lobes do not exist, and that, from this circumstance, there is always a greater or less amount of cerebellum projecting behind the

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* See Professor Huxley, Dr Allen Thomson, Dr Rolleston, and Mr Marshall, in vol. i. of "Natural History Review," 1861; Professors Van der Kolk and Vrolik in January No. for 1862; Professor Huxley, "Proceedings Zoological Society," 1861; Mr Flower, "Proceedings Royal Society of London," 20th June 1861, and 9th January 1862.

cerebrum, and uncovered by it. Tiedemann* has, however, made an exception in favour of the seal, in which animal he says posterior lobes occur, although shorter than in the Simiæ. Cuvier† also recognises the exceptional arrangement in the seal, and places along with it the otter and the dolphins. Retzius‡ states, that in the mammalia lower than man, posterior lobes are found only in the apes, and that rudiments only are met with in the Cetacea and seals.

In the course of a series of observations which I have been making for some time back, on the crania of different mammals, my attention has been especially directed to the relative positions of the cerebrum and cerebellum. These observations have led me to come to the conclusion, that considerable misconception exists as to the relations of the two chief divisions of the encephalon.

If, relying on the published drawings, one may give an opinion of the method of examination of the brain which has been mostly adopted by anatomists, it would appear that the relation of the constituent parts of the brain has been determined after its removal from the cranial cavity, and with its base resting on a flat surface, such as a plate. By a procedure of this kind a very incorrect estimate is formed, for great displacement of parts ensues, especially in the lower mammals. The cerebrum slips forwards, the cerebellum backwards. The medulla, instead of being more or less oblique, is placed horizontally, and causes the cerebellum to be tilted upwards. The arched form of the base is almost entirely destroyed. The displacement is still greater if, at the same time, the membranes are removed.§ The observations which I have conducted have been, for the most part, made without removing the brain from the cavity of the skull. My dissections have been performed chiefly after two methods: 1*st*, By making vertical sections through both skull and brain, immediately on one side of the middle line, so as to preserve uninjured the falx cerebri, and the whole of one lateral half of the organ; 2*d*, By carefully removing with the bone-forceps the pos-

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* Icones Cerebri Simiarum, p. 48.

† Leçons d'Anatomie Comparée, vol. iii., 1845.

‡ Müller's Archivs, 1846, p. 154.

§ Mr Marshall, in his description of the brain of a young chimpanzee (Nat. Hist. Rev., vol. i. p. 298), has pointed out very clearly, in the brain of that animal, the changes which ensued after removal from the skull, and immersion for a time in spirit.

terior part of the skull. By this latter method, especially, a view may be obtained of the cerebellum and cerebrum as they lie *in situ*. Owing to the transparency of the dura mater in many of the lower mammals, the relations of these structures to each other may be studied, either with or without the removal of this membrane.

Comparative anatomists, in describing these relations, are in the habit of employing such terms as overlapping, covering, exposure, denudation, to express their extent. Such terms are not, however, sufficiently precise, because they do not convey distinctly which surface of the cerebellum it is which is thus overlapped, covered, exposed, or denuded. Indeed, it is seldom that the attempt has been made, in the lower mammals, to give an accurate definition of these surfaces, so as to distinguish them from each other. Before a close and accurate comparison can be instituted between the relations of the cerebrum to the cerebellum in man and other mammals, it is necessary that such a definition be attempted. It has appeared to me that the septum lying between the cerebrum and cerebellum, commonly termed the tentorium cerebelli, furnishes us with a basis for arriving at a precise conclusion.

If we turn to the descriptions of the cerebellum of man, given in our standard text-books of human descriptive anatomy, we shall find it stated that the cerebellum consists of a central median part—the vermiform process, or worm; and of two lateral lobes—the hemispheres. Of these, the hemispheres preponderate greatly in size. The cerebellum presents an upper and lower surface, and a circumference. The upper surface corresponds to the tentorium cerebelli; the lower is lodged in the concavity of the inferior occipital fossæ, to which it is accurately adapted. The circumference of the cerebellum corresponds to the line of junction of the upper and lower surfaces with each other, and along it a deep fissure, the great horizontal fissure, extends. The circumference—called also the posterior margin—corresponds, therefore, to the line of attachment of the tentorium to the transverse line of the occipital bone, and marks with great precision the divergence of the two surfaces of the cerebellum from each other. Of these surfaces, that which is superior, and in contact with the tentorium, which we may therefore appropriately term tentorial, is the only one related to the cerebrum, the posterior lobes of which not only cover, but even project beyond it. The inferior surface, in contact with the occipital bone, which may therefore be termed occipital, never possesses any relation whatsoever to the cerebrum.

An examination of several members of most of the great orders of the class Mammalia has satisfied me, that it is quite possible to arrive in them at as correct a conception of the relations of the cerebrum to the cerebellum as in man. In every animal which I have examined, I have found the cerebellum to possess two surfaces. One of these is in contact with the tentorium, and, through the intervention of that membrane, is in relation to the cerebrum. The other is in contact with the wall of the occipital fossa. The surfaces are distinguished from each other by looking in different directions. The tentorial, corresponding to the superior in man, looks, as a rule, more or less forwards. The occipital, corresponding to the inferior in man, looks, as a rule, more or less backwards. These surfaces along their line of junction form an angle, more or less marked in different animals. This angle corresponds to the circumference, or posterior margin, of the human cerebellum, and is in contact with the line of attachment of the tentorium to the occipital bone. The tentorial aspect of the cerebellum, therefore, is that which is in constant relation to the cerebrum, and, not only in man, but in all the mammalia, is covered by it.

That this is the case with regard to the Quadrumana, has been so completely proven by the observations of the various anatomists already referred to, that it appears almost unnecessary to enter again into this question. As I have had an opportunity of dissecting *in situ* the brain of a young and recently dead Cercopithecus, which was given me by my friend Dr M'Bain, I may mention that in it the posterior cerebral lobes not merely covered the tentorial surface of the cerebellum, but projected decidedly beyond its posterior margin. Through the liberality also of Professor Goodsir, I have obtained permission to examine several quadrumanous brains in his possession. All these had been removed from the cranial cavity, and had been lying for some time in spirit.

In a Chimpanzee, the tentorial surface of the cerebellum was directed upwards, and was evidently flatter than the corresponding surface in man. The occipital surface was directed downwards. The posterior margin was clearly marked. The posterior lobes of the cerebrum corresponded to the whole of the tentorial surface, and extended as far as the posterior margin of the cerebellum, beyond which they might even be stated slightly to project. The inferior vermiform process was lodged in a slight furrow between the two cerebellar hemispheres.

In the brains of several specimens of Cercopitheci, the tentorial and occipital surfaces, with the posterior margin of the cerebellum, were distinctly marked. In all, the posterior cerebral lobes extended over the tentorial surface as far as the posterior margin. In two of the brains, it might be stated that the cerebral lobes projected backwards beyond that margin. The comparatively greater development of the inferior vermiform process, over the lateral hemispheres of the cerebellum, was indicated by the absence of that fossa between the hemispheres in which it lies in the more highly developed human cerebellum.

In a Macacus, a vertical section through the skull and brain of which animal I examined, the cerebrum corresponded to the tentorial aspect of the cerebellum; the posterior lobes of the one and the superior surface of the other extended as far as the margin of attachment of the tentorium to the transverse line of the occiput.

In two specimens of Cynocephali, the same relation of the posterior lobes of the cerebrum to the tentorial aspect of the cerebellum was observed. In neither of these brains was the inferior vermiform process lodged in a depression between the hemispheres, but formed an almost continuous surface with them.*

In three brains, from animals of the genus Ateles, the posterior cerebral lobes extended quite up to the posterior margin, separating the tentorial from the occipital surface of the cerebellum. In all the lateral hemispheres projected slightly beyond the inferior vermiform process, which was lodged in a shallow depression between them.

In a lion monkey (*Midas leoninus*) the occipital surface of the cerebellum was separated from the tentorial by a very clearly defined

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* Since this paper was read before the Society, I have dissected *in situ* the brain of a young Shacma, and have found that the cerebrum projected beyond the cerebellum, both laterally and posteriorly. The vermiform process protruded slightly beyond the cerebellar hemispheres. The projection of the cerebral hemispheres backwards beyond the worm was rather less than $\frac{3}{10}$ths of an inch, whilst on each side of the worm it extended to rather more than $\frac{3}{10}$ths of an inch behind the cerebellar hemispheres. The cerebellar and posterior cerebral fossæ in the cranium exhibited an arrangement in conformity with this disposition of the encephalon. (*March 27th.*)

posterior margin, as far as which the posterior cerebral lobes extended. The inferior vermiform process projected beyond the cerebellar hemispheres, which were comparatively feebly developed.

The Cetacea possess, not only in their great mass of brain, but in the number and complexity of the convolutions of their hemispheres, very decided evidences of a high degree of cerebral organisation. Professor Goodsir has allowed me to examine the brains of a porpoise, a bottle-nosed dolphin (*D. Tursio*), and a rorqual (*Balænoptera*), either in his possession, or in the Anatomical Museum. In all, in accordance with the peculiar antero-posterior compression of the cranial cavity, the corresponding diameter of the cerebral hemispheres was very much shortened, so that the brain was widened out, and heightened greatly in its vertical diameter. In all, the distinction between the tentorial and occipital surfaces of the cerebellum was very clearly marked. The cerebrum passed backwards as far as the posterior margin of the cerebellum. The cerebellum in them was a cerebellum inferius; for, as far as could be judged from an inspection of the brains, as they lay out of their cavities, the cerebellum was not exposed when looked at from above. The cerebrum possessed very decided posterior lobes; for, on account of the great extent of the tentorial surface of the cerebellum, and the heaping up of the cerebral convolutions in the vertical diameter, a large proportion of the cerebral hemispheres was placed above the cerebellum.* The brain of the bottle-nosed dolphin had been lying for many years in spirit in the Anatomical Museum. A section had been made into the lateral ventricle on the right side, from which it appeared as if there were indications of a prolongation of the ventricle in the direction of the posterior lobe. When the dissection was extended, so as to obtain a more complete view of the arrangement, it was seen that the lateral ventricle was continued backwards and outwards, sweeping along the posterior part of the optic thalamus. It then changed its direction, and passed downwards and forwards, so as to form the inferior horn. At, or about, the spot where this change took place, a recess, extending backwards in the substance of the cerebral mass was met

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* Each hemisphere of *Delphinus Tursio*, measured 5 inches and $\frac{8}{10}$ths in its antero-posterior diameter. The cerebrum extended 2 inches and $\frac{4}{10}$ths behind the posterior end of the corpus callosum, the inferior surface of which mass of cerebrum was in relation to the tentorial surface of the cerebellum.

with. This recess, from its position and curvature, must, I think, be regarded as a rudimentary posterior cornu. As the soaking of a brain in spirit, for a series of years, has a tendency to render the examination of the ventricular arrangements more difficult, than would be the case in a recent brain, I hope, in the course of the summer, to supplement this observation, by an examination of the brain of the common porpoise.

In the brains of those Carnivora which I have been able to examine, the cerebellum has been seen to possess tentorial and occipital surfaces, separated by a slight, yet definite, ridge, which corresponded to the line of attachment of the tentorium to the occipital bone. The cerebellum is not, however, so decidedly a "cerebellum inferius" as in the examples already described. The surfaces of the cerebellum consequently look more or less forwards and backwards. Thus, if we look from above upon the brain of a dog or cat, we see the cerebellum projecting slightly behind the cerebrum, or exposed, as it is usually stated. From the description which has been given by Tiedemann* of these relations, not only in the Carnivora, but in the Ruminantia, Solipeds and Pachydermata, it is evident that he considered a portion, at least, of this exposed surface belonged to the anterior aspect of the cerebellum. But if we examine the brain *in situ*, we shall see that the posterior end of the cerebrum passes as far as the posterior margin of the anterior (tentorial) surface of the cerebellum, so as to cover it. The exposed surface is, therefore, the occipital, or that which corresponds to the inferior surface of the human cerebellum. In the dog, both the tentorial and occipital surfaces of the cerebellum are well developed and about equal in extent. The amount of cerebral hemispheres in relation, through the tentorium, to the corresponding cerebellar surface, is therefore considerable, and warrants us, I think, in regarding them as posterior lobes. The lateral ventricles do not possess any proper posterior cornua; but a slight indentation, continuous with the ventricular cavity, in the substance of each posterior lobe, appears to me to present a rudiment of the posterior horn. In the cat, the tentorial is smaller than the occipital surface of the cerebellum, and the extent of cerebrum in relation with it is proportionally smaller than in the dog, so that the size of its posterior lobes is smaller; for the area of

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* Anatomie und Bildungs-geschichte des Gehirns, &c. Nürnberg, 1816. P. 147.

the tentorial surface of the cerebellum may be taken as a measure of the amount of the posterior part of the cerebrum by which it is covered. Its lateral ventricles possess no traces of posterior horns.

I have already mentioned that both Tiedemann and Cuvier have noted that the seal possesses more largely developed cerebral hemispheres than the Carnivora generally; and Cuvier places, along with the seal, the otter. I have, as yet, had no opportunity of examining the brains of these animals, but the accompanying casts of the interior of their cranial cavities will give some conception of the relations of the cerebellum and cerebrum.*

In the otter, the cerebrum not merely covered the tentorial aspect of the cerebellum, but even projected beyond it in a very striking manner. Thus, when the brain was looked at from above, no part of the cerebellum was exposed. From the cast, it would appear as if the occipital surface of the cerebellum looked almost directly backwards. The cerebral hemispheres possessed considerable width posteriorly. In the seal, nearly the same relations prevailed as in the otter; the posterior projection of the cerebral hemispheres was more strongly marked laterally than in the middle line. This was due partly to the ossification of the tentorium and falx cerebri, and partly to the posterior cerebral fossæ not passing quite so far back in the middle line as they did somewhat further outwards.

An inspection of the interior of the cavity of a cranium, in my possession, of a walrus (*Trichecus*), an animal closely allied to the seal, led me to suppose that, if a cast of the cavity were taken, relations of a similar nature would be met with. I, accordingly, made such a cast, and found that the cerebral hemispheres projected backwards beyond those of the cerebellum; this projection, as in the seal, and from the same cause, being more strongly marked laterally than in the middle line. The occipital surface of the cerebellum was almost flat, and directed backwards, with but a slight upward inclination. Both the seal and the walrus may be considered to possess brains of large size, so that the cerebellar hemispheres were concealed by the cerebral lobes when the brain was looked at from above. In them as well as in the otter the cerebellum was inferior.

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* Most anatomists, I think, will admit that a very correct general conception of these relations may be obtained in those cases where it is difficult to procure the brains themselves, by making casts of the cranial cavity. The accuracy of this method is ensured, even more absolutely, when the tentorium is ossified.

If one might form an opinion, from the casts of the cranial cavities of these animals, of the size of their posterior cerebral lobes, it is not improbable that they might be found to possess indications of posterior horns to the ventricles. I shall certainly avail myself of the first opportunity which may present itself, to inquire into this point. Besides, I find that Tiedemann in his "Icones," p. 19, in a description of the brain of a *Phoca vitulina*, states, "præterœa cornu posterioris vestigium occurrit."

Of the Pachydermata and Ruminantia, I have examined *in situ* the brains of the pig and sheep. In both these animals the tentorial and occipital surfaces of the cerebellum were clearly indicated by the line of attachment of the tentorium to the occipital bone. In both, the cerebral hemispheres extended backwards as far as that line, so that the tentorial surface of the cerebellar hemispheres was completely covered by it. In the pig, the tentorial surface of the cerebellum was larger proportionally than in the sheep, so that the extent of cerebrum in relation to the cerebellum was greater. When the brain of either animal was examined from above, a partial projection of the cerebellum behind the cerebrum might be seen; but the exposed surface was the occipital, and not the tentorial. From an examination of the brains, preserved in spirit, of the Wart-hog (*Phasco-chæres*) and Peccari (*Dycoteles*) in the possession of Professor Goodsir, it would appear, that in them, as in the common pig, the tentorial surface is covered by the cerebrum.

In the Rodentia, Insectivora, Cheiroptera, and Marsupialia, the cerebellum is no longer placed below the cerebrum, but behind it, so that it becomes really a cerebellum posterius. From the statements which have been made in the works of several anatomists of great distinction, it would appear to be their opinion that the cerebrum has, in these orders, so slight a relation to the cerebellum, that the *corpora quadrigemina* are more or less exposed between the two.* From an examination which I have conducted *in situ*, of the brains of several members of these important groups, I think it very doubtful whether such a general statement is correct. Of the Rodentia, I have examined the rabbit, guinea-pig (*Cavia cobaia*), and rat. In all these animals it was quite possible to distinguish a tentorial and occipital surface in the cerebellum. The area of the

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* Tiedemann, Anatomie des Gehirns, p. 146; Icones, p. 48. Craveilhier, Descriptive Anatomy, p. 1013. Stannius, Lehrbuch, pp. 389, 390.

former was small, and possessed a forward direction. The latter was much larger, and at first sight appeared to be the only surface which the cerebellum possessed. It was directed more or less upwards and backwards. The separation between the two surfaces was indicated by a slight ridge which corresponded to the line of attachment of the tentorium to the occipital bone. As far as this line the cerebrum extended posteriorly. The anterior surface of the cerebellum was thus in relation, through the tentorium, with the cerebrum. Owing to the limited area of this surface, the amount of cerebrum in relation to it was necessarily extremely small, and might be considered as little more than the posterior edge of the cerebral hemispheres. Neither in the rabbit nor guinea-pig could the *corpora quadrigemina* be seen, until the cerebral hemispheres were drawn on one side, or the cerebellum pushed back. In the rat, the hemispheres of the cerebrum were in relation to those of the cerebellum; but, in the middle line, owing to their divergence from each other at the posterior end of the great longitudinal fissure, the upper aspect of the *corpora quadrigemina* could be seen. When a bird's-eye view of the brain was made, a large proportion of cerebellum was exposed lying behind the cerebrum, but this exposed surface was the occipital. Tiedemann, in his "Icones," has illustrated the anatomy of the brain of the Rodentia, by figures of the brains of the agouti (*Cavia agouti*), porcupine, and beaver. In every instance he has represented the cerebrum lying so far in front of the cerebellum as not to be in contact with it. Thus, exposure of the *corpora quadrigemina* is occasioned. From my dissections I am satisfied that this mode of depiction does not give a faithful representation of the relation of the structures. The error has evidently arisen from studying the parts after removal from the cavity, and without taking properly into consideration the relations which they bore to each other *in situ*.

Of the Insectivora, I have dissected *in situ* the brains of the mole and hedgehog. Of the Cheiroptera, I have dissected but one species. In these animals the surfaces of the cerebellum had about the same relation, as regards direction and size, as in the Rodentia. In all, the small tentorial surface was in apposition with little more than the posterior edge of the cerebrum. In none of the animals examined could the *corpora quadrigemina* be seen until the cerebral hemispheres were turned on one side.

Of the Edentata and Monotremata I have, as yet, had no opportunity of dissecting any specimens.

Of the Marsupialia, through Professor Goodsir's kindness, I have been enabled to examine two brains of the kangaroo (*Macropus*). Although these brains had been for some time in spirit, and had evidently to some extent lost their original form, yet it was possible to distinguish in them the tentorial and occipital surfaces of the cerebellum, and to note that the cerebrum had to the former a relation corresponding to that which had been noted in the mammals already described. In the kangaroo, therefore, the exposed surface of the cerebellum is the occipital. The *corpora quadrigemina* could not be seen until the cerebral hemispheres were drawn to one side.

(The paper was illustrated by crania, casts, photographs, and drawings. The drawings were made by Dr Henry S. Wilson, and, to ensure accuracy of form, proportion, and relation, their outlines were taken with the assistance of a camera.)

3. On the Connection between Organic Force and Crystalline Force. By H. F. Baxter, Esq.

The following Donations to the Library were announced:—

Neue Denkschriften der allgemeinen schweizerischen Gesellschaft für die gesammten Naturwissenschaften. Zürich. Bänder XVII. und XVIII. 1860–61. 4to.—*From the Society.*

Mittheilungen der naturforschenden Gesellschaft in Bern, aus dem Jahre 1858. No. 408–423, No. 424–439, No. 440–468. 8vo.—*From the Society.*

Verhandlungen der schweizerischen naturforschenden Gesellschaft bei ihrer 43-ten Versammlung in Bern den 2, 3, und 4, August 1858. 8vo.—*From the Society.*

Atti della Società Elvetica delle Scienze Naturali riunita in Lugano nei Giorni 11, 12, e 13 settembre 1860; Sessione 44ª. 8vo.—*From the Society.*

Sitzungsberichte der Wissenschaften zu München, 1861. I. Heft V. 8vo.—*From the Academy.*

The Journal of the Chemical Society. No. LVIII. 1862. 8vo. —*From the Society.*

Journal of the Asiatic Society of Bengal, No. CVIII. 1861. 8vo.—*From the Society.*

The Journal of Agriculture and the Transactions of the Highland and Agricultural Society of Scotland, No. 76. 8vo.—*From the Society.*

Quarterly Return of the Births, Deaths, and Marriages registered in the Divisions, Counties, and Districts of Scotland. No. XXVIII. 8vo. Supplement to the above.—*From the Registrar-General.*

Supplement to the Monthly Returns of the Births, Deaths, and Marriages registered in the eight principal towns of Scotland. Year 1861. 8vo.—*From the same.*

Monthly Return of the Births, Deaths, and Marriages registered in the eight principal towns of Scotland. January 1862. 8vo.—*From the same.*

Illustrations of the genus Carex. By Francis Boott, M.D. Part III. Tab. 311–411. Folio.—*From the Author.*

Monday, 17*th March* 1862.

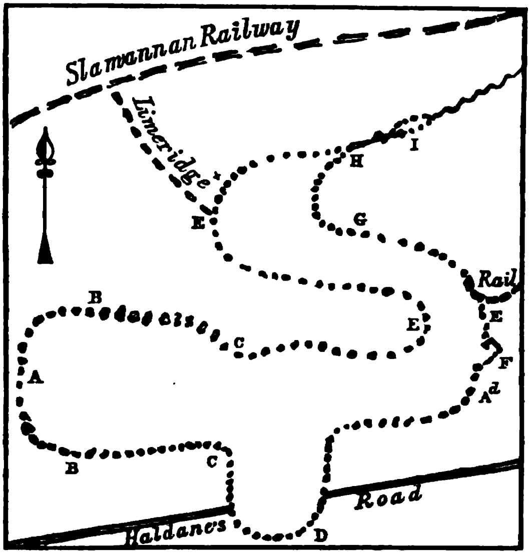
Dr CHRISTISON, V.P., in the Chair.

1. On a recent Landslip. By the Rev. John Duns, Torphichen.

In the introduction to this paper, the author pointed out the prominent physical features of the district in which the landslip occurred. At the point where the trap-ridge, which stretches in a south-west direction from Linlithgow to the neighbourhood of Airdrie, sends one irregular fork to the north-west, and another to the south-west, a broad depression occurs. In this lies the Auchingray moss, the scene of the landslip. Here the parish of New Monkland, Lanarkshire, meets that of Slamannan, Stirlingshire. The following figure is a rough plan of the ground between the Slamannan Railway and Haldane's Moss Road. The area specially influenced by the landslip is enclosed by dotted lines.

The space lying between A and CC, represents the landslip proper. The rest of the ground marked off was that covered by the flow. At present, heath-clad ridges appear at A and BB. These ridges were previously little, if at all, above the level of the moss.

The depression is the result of the immense quantity of soil carried away while the force lasted. Between BB, the centre of the slip, the author on sounding some of the water-filled gaps found them sixteen feet deep.



At A, where the effects of the slip are first seen, the soil has fallen in irregular masses to the east. At the widest part, BB, that lying on the north has given way to the south, and that lying on the south has fallen to the north. The pressure on three sides has been towards the centre, where the depth is greatest. This, the author showed, seemed to indicate, that the force had first become active at that point, and to suggest the explanation of the movement. About forty years ago, the central part was known in the district as the "*blind loch*,"—water covered with reeds, rushes, &c.

The movement of the soil began about seven A.M., 12th August 1861. The author visited the locality a few days later. Heavy rains had fallen for some weeks. August 11th was one of the wettest days of the season, and the wind blew strongly from the west. Great quantities of water had got between the peat and the underlying clay, and had floated the lightest central part. Denser matter would then press in from the sides A and BB, and give greater impetus to the floating mass. The slip, having carried away the breast-work, would naturally take the direction of least resistance, —viz. the course of the stream which drains the moss.

The area set in motion was estimated at about 300 feet broad at its widest part, BB, and 1320 feet long, from A to A*d*. The slip met with slight elevations at CC; the most formidable of which lying on the north, gave the flow a southerly direction, and led to the deposit of the tongue marked D. Here it spread over portion of a corn field, covered part of the highway, Haldane's Moss Road, and wasted part of a field of turnips lying on the south side of the road.

At the point where the moving material turned to the south, evidences of great disturbance are to be seen. In some cases, huge masses of peat have been turned upside down; and, as they were pushed over sunken portions, their faces now rest on what formerly formed the surface of the ground. On the lumps thus inverted, many branches and roots of native birch trees (*Betula alba*) were to be met with. No birches now grow in the immediate neighbourhood. It was shown that no trees of any sort grew near the moss in 1809; and the birches, it was concluded, had been laid down long anterior to that date. A peculiarity of their roots was pointed out. Many of the main stems, instead of being rounded, have a central depression on both sides, are flat, recurved, and run quickly to a point. Fragments of land shells (Zonites) were picked up among these roots.

At D, the floating material turned again to the north, and bending N. by E., it came in contact with a plantation of Scotch firs. A few of the trees have been carried several yards forward, and now stand as if they had not been moved from their place. Several have been thrust violently, top downwards, into the underlying clay, and others have been placed horizontally on the edges of arrested masses of peat. In its course, much damage was done by the slip to other two corn-fields. At F, it filled a whinstone quarry about fifteen feet deep. At the bend EE, the soil in motion must have been at least twelve feet deep. The great body of the peat, which had been set in motion on the 12th of August, took six days before it reached in bulk the point I, a haugh on each side of Binniehill Burn, where it covered a space described as being as wide as the Clyde near Glasgow. On the 15th, the movement was at the rate of about a yard in two minutes.

A little beyond the neck EE, it met the Limeridge Railway, carried away part of it, and covered it between E and G. It spread over the natural basin marked GG, where it left large masses. One measured seven feet by four feet, and was nearly five feet deep. At H it entered Binniehill Burn, and covered the haugh I. The next point favourable for it spreading occurs in the haugh on the south and east of Slamannan village. At this place it covered the highway at two points, and left about two feet of peat soil on the surface of the clay, at that time under cultivation. Having reached the Avon, the flow left broad marks on its banks, as far down as Linlithgow bridge, thirteen miles distant.

The author, in conclusion, pointed out resemblances between the Auchingray landslip and that of the Solway in 1771, and referred to phenomena associated with the Slip now noticed, fitted to shed light on several questions bearing on the formation of modern strata.

2. On the Rainfall in the Lake District in 1861. With some Observations on the Composition of Rain-Water. By John Davy, M.D., F.R.SS., Lond. and Edin.

This paper consists of two parts. In the first part an account is given of the rain-fall in the Lake District during the year 1861, chiefly remarkable for its great amount (exceeding the average by many inches), and varying in different localities from sixty inches on the skirts of the district, for instance, at Kendal and Mirehouse, the latter four miles northward of Keswick, to 123 and 182 inches ; the former, the fall at Grasmere, where approaching the higher mountains, the latter at Seathwaite in Borrowdale, a spot in the midst of them.

In the second part an account is given of the author's observations and experiments on rain, in relation to composition, as examined microscopically and chemically.

The results of both trials seem to prove that rain-water is rarely, if ever pure, and that almost constantly it is the vehicle of saline matter, probably derived from the sea, and of other matter as well as saline, probably derived from the land, especially from our great manufacturing districts, and that in each and every instance, the impregnations it contains are raised and diffused by the winds.

The diffusion of matter thus affected is so strongly marked, that, in the author's opinion, it seems to prove that as there is a circulation of water from the sea to the land, and from the land back to the sea, so there is one of saline matter, tending to prevent the perfect exhaustion of the soil, and to favour the growth of herbage on our downs and fells, and of shrubs and trees, where manure never is, and never has been employed.

Whilst in the economy of nature this diffusion is presumed to act beneficially, on the works of man it seems to act in an opposite manner,—being rather destructive than preservative,—rain promoting the decay of all, or almost all, inanimate objects of a perishable kind exposed to its influence, and this mainly by its saline contents.

3. Observations on the Absorbing Power of the Human Skin. By Murray Thomson, M.D., F.C.S., Lecturer on Chemistry, Edinburgh. Communicated by Dr Douglas Maclagan.

For the last sixty years physiological and other authors have been maintaining two very opposite views in regard to the absorption by the skin of substances dissolved in the water of baths. Some authors holding that such salts as iodide of potassium readily reach the blood through the skin, when applied in the form of a bath containing that salt; while others hold that absorption, under such circumstances, never takes place. Among those who hold the affirmative view, I may mention Braconnot, Madden, O'Henry (fils), Carpenter, Chevallier et Petit; and among those who hold the opposite opinion, Currie, Seguin, Lehmann of Leipzig, Kletzinsky.

This long lasting difference of opinion sufficiently indicates, I think, that the subject is surrounded by difficulties. I do not presume, therefore, that the observations I have made settle the question, they are only intended as a contribution to our knowledge on the subject.

My experiments were all made on my own person at various intervals during the last two years. Six of them were made on as many successive nights, so as to try if frequency of bathing rendered the skin more permeable. The general method of making the trials was this:—Into an ordinary bath, a measured quantity of warm water was let, the temperature of which was recorded. Means were taken to keep the heat constant during the experiment. The temperatures ranged usually from 90° to 98°. The salt to be tried was then dissolved, and mixed with the water. The time in the bath was noted; it varied from half an hour to one hour and a quarter. The whole body was immersed, excepting the head and neck. All the urine voided in twenty-four hours after each bath was collected and concentrated, then tested for the substances experimented on. Six baths were taken, in which iodide of potassium was dissolved. The quantity of the salt varied from 200 to 1300 grains.

Five baths, in which quantities of ferrocyanide of potassium, varying from 1400 to 5000 grains, were dissolved. Four baths were taken, the water of which was rendered strongly alkaline by soda. The result of these fifteen experiments was, that I could not find that any of the substances in the baths passed through the skin into the blood, so as to be found in the urine; the soda baths did not render it alkaline, nor could I detect the other salts in it; and it is to be noted that the tests for them are extremely delicate.

To compare absorption from a mucous surface with the above, I swallowed several different quantities of iodide and ferrocyanide of potassium, when I found that the smallest amount of the former salt I could take internally, and afterwards detect in the urine, was two grains, and of the latter five grains.

A considerable number of trials were made in which tincture of iodine, and two in which iodine ointment were applied to the skin. Neither in these could I afterwards find iodine in the urine.

The general conclusion which my experiments lead me to are, (1.) That though not denying that absorption by the skin of aqueous solution does take place, yet it seems to be the exception and not the rule. (2.) That medicated warm baths, whether natural or artificial, do not appear to owe any virtue they may have to the substances dissolved in them reaching the blood through the skin. At the same time, as there are other ways by which one can conceive such baths to operate on the system, it is not to be concluded that, because absorption may not take place, such baths are useless as therapeutic agents.

4. On the Constitution of Mannite. By J. A. Wanklyn, Esq., and Dr Erlenmeyer.

Chemists are in the habit of assigning to mannite the formula,

$$C_6H_{14}O_6;$$

but the reasons which have hitherto been given for that formula seem not very conclusive. By a process of fermentation, alcohol and a number of other compounds of well established composition may be obtained from mannite; but inasmuch as disintegration takes place in this process, the formulæ of the products afford no guide to the constitution of the original body.

Up to the present time no compound of known formula has been got from mannite by other than disintegrating processes.

The uncertainty about the real composition of mannite has finally been illustrated by Berthelot, who in his "Chimie organique fondée sur la Synthèse," has proposed the formula,

$$C_3H_7O_3.$$

Berthelot has supported his view by bringing forward a number of salts of mannite, and has hinted at the possibility of preparing the substance from allyl compounds.

The reaction we have to bring forward in this paper is in contradiction to Berthelot. By distilling mannite with a great excess of strong hydriodic acid, in a stream of carbonic acid gas, it is almost completely resolved into Iodide of Hexyl. The change may be thus represented :—

$$\overset{\text{Mannite.}}{C_6H_8(HO)_6} + 11HI.$$

$$= \overbrace{C_6H_{13}I}^{\text{Iodide of Hexyl.}} + 6H_2O + I_{10}.$$

This reaction is conclusive against Berthelot's formula, for it cannot be maintained that an easy reduction with hydriodic acid would increase the complexity of the carbon molecule. A parallel reaction between glycerine and hydriodic acid was observed by one of us some time ago.*

$$\overset{\text{Glycerine.}}{C_3H_5(HO)_3} + 5HI =$$

$$\overbrace{C_3H_7I}^{\text{Iodide of Propyl.}} + 3H_2O + I_4.$$

We are thus conducted to the result: mannite is the hexatomic alcohol of the C_6 series, or, as we prefer to write, Mannite is

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* Erlenmeyer. Zeitschrift für Chemie ü. Pharmacie.

Hexyl-hydride, wherein six atoms of hydrogen have been replaced by six atoms of peroxide of hydrogen.

From the recognised connection subsisting between mannite and the sugars, we may expect that the sugars also belong to the Hexyl-hydride series.

Furthermore, just as glycerine has been got from the Propyl series, so may we hope to get mannite from the Hexyl series. It is our intention to attack this problem. We propose to make $C_6H_8Br_6$, and to endeavour by some means to effect a replacement of the Bromine by peroxide of hydrogen.

We subjoin a slight sketch of a few hexylic compounds. Iodide of hexyl $C_6H_{13}I$. (obtained from mannite), is a colourless liquid, having a smell very like that of iodide of amyl. It is very slowly acted upon by light; sp. gr. = 1·439 at 0° C. Boiling-point about 165° C. It can be distilled without suffering decomposition.

Hexyl-alcohol $C_6H_{13}HO$ may be obtained by decomposing the iodide of hexyl by means of oxide of silver and water. Its smell does not bear the slightest resemblance to that of amyl-alcohol.

Hexylene C_6H_{12} is obtained by digesting iodide of hexyl with alcoholic solution of caustic potash. It is a light oil, smelling like amylene; boiling-point about 69° C. Its vapour-density has been found to be 2·88 and 2·97. The formula C_6H_{12} requires 2·9022. It combines with great violence with bromine, yielding

$$C_6H_{12}Br._2.$$

Hexyl-hydride, C_6H_{14}, may be obtained by decomposing the iodide with zinc in presence of alcohol. It is a light oil, having a very fragrant smell, and not attacked by Bromine at any rate in diffused daylight. In these two particulars it differs widely from hexylene, which has an abominable smell, and which hisses when Bromine is dropped into it. In boiling point there is very little difference between hexylene and hexyl-hydride.

All of these compounds have given satisfactory analyses.

[We intend to publish a full account of the Hexyl-compounds.]

The following Gentleman was admitted an Ordinary Fellow.

NICHOLAS ALEX. DALZELL, Esq., A.M., Conservator of Forests, and Superintendent of the Botanical Garden, Bombay.

The following Donations to the Library were announced:—

History of the University of Edinburgh from the Foundation. By Andrew Dalzel, Professor of Greek. With Memoir of the Author. By Professor Cosmo Innes. Two vols. 1862.—*From Miss Dalzel.*

Reise der österreichischen Fregatte Novara um die Erde in den Jahren 1857–1859, unter den Befehlen des Commodor B. von Wüllerstorf Urbair. Zwei Bänder. 8vo. Wien, 1861. —*From the Austrian Government.*

Verslagen en Mededeelingen der Koninklijke Akademie van Wetenschappen Afdeeling Natuurkunde. Elfde Deel. 8vo. Amsterdam, 1861.—*From the Academy.*

Verslagen en Mededeelingen der Koninklijke Akademie van Wetenschappen Afdeeling Natuurkunde. Twaalfde Deel. 8vo. Amsterdam, 1861.—*From the Academy.*

Jaarbock van der Koninklijke Akademie van Wetenschappen Gevestigt te Amsterdam voor 1860. 8vo.—*From the Academy.*

Verhandelingen der Koninklijke Akademie van Wetenschappen. Negende Deel. Met Platen. 4to. Amsterdam, 1861.—*From the Academy.*

Journal of the Statistical Society of London. Vol. XXV. Part 1. 8vo. March 1862.—*From the Society.*

Journal of the Proceedings of the Linnean Society. Vol. VI. No. 22. March. 8vo.—*From the Society.*

Proceedings of the Royal Horticultural Society. March, 1862. 8vo.—*From the Society.*

Monthly Return of Births, Deaths, and Marriages registered in the eight principal towns of Scotland. February 1862.—*From the Registrar-General.*

On Earth-currents and their connection with the Diurnal Changes of the Horizontal Magnetic Needle. By the Rev. Humphrey Lloyd, D.D., D.C.L., F.R.SS. L. and E., M.R.I.A., &c., Fellow of Trin. Coll. Dublin. From the Transactions of the Royal Irish Academy. 4to. 1862.—*From the Author.*

Monday, 7th April 1862.

The very Rev. DEAN RAMSAY, V.P., in the Chair.

The following Communications were read :—

1. On the Structure of *Lerneopoda Dalmanni,* with Observations on its Larval Form. By Wm. Turner, M.B. (Lond.), and H. S. Wilson, M.D., Demonstrators of Anatomy.

This apparently little known form of parasitic crustacean has been as yet described only by Retzius and Kröyer. It does not appear, up to this time, to have been recognised as a British species. During the present year, many specimens obtained from the nasal cavity of more than one *Rasa batis*, caught by the Newhaven fishermen, have been examined by the authors.

Female.—One of the largest of the Lerneadæ, divided into cephalo-thorax and abdomen by a constricted neck. Cephalo-thorax $\frac{4}{10}$ths of an inch long; it projected almost at a right angle from the anterior end of the abdomen. On its dorsal surface were a pair of 3-jointed hooked antennæ. In front of the antennæ, and close to the anterior end of the head, was the buccal apparatus. Situated in the middle line was a short, conical, retractile snout, which possessed an oral aperture bounded by two fringed lips at its extremity. The structure of these lips, with that of the jaws and palpæ connected to them, was then fully described. On each side of the snout is a short stump-like process—a modified foot. It was segmented, and possessed a bifid, free extremity, the posterior division of which was armed with a terminal hook; the anterior division, much larger than the posterior, was studded with short bristles. Connected to the base of each stump-like process was a segmented palp-like structure, set with three or four conical papillæ at its free end.

Springing from the sides of the cephalo-thorax, immediately in front of the neck, was a pair of elongated cylindrical arms. Each arm ended superiorly in an expanded clasper. The two claspers were in close contact by flattened, opposed surfaces, but not united together. In the concave upper surface of the opposed claspers a cartilaginous-like bar was placed. The authors then described the structure of the arms and the bar, and the mode of connection of the parasite through these arrangements to the wall of the nasal chamber of the skate. The structure of two bulb-like protuberances from the sides of the cephalo-thorax, immediately in front of the roots of the arms, was then described. These were the eye-like spots of Retzius and Kröyer.

Abdomen $\frac{7}{10}$ths of an inch long, $\frac{4}{10}$ths broad; had an inverted heart-shaped form; imperfectly defined segmented appearance. The fourth segment, the largest, possessed a median slit-like anal aperture, two elongated ova strings, and two posterior abdominal appendages. The arrangement of the intestinal canal, ovaries, and cement organ was then described. The authors then pointed out certain appearances which they considered indicative of the existence of a nervous system.

The authors agreed with Milne-Edwards in thinking that the elongated cephalo-thorax and the posterior abdominal appendages point decidedly to the advisability of separating this animal from the genus lerneopoda. None of the specimens they examined had the male attached, so that they have not examined it. They have seen the larvæ in various stages of development. When free, the larva was $\frac{1}{37}$th of an inch long and $\frac{1}{60}$th of an inch broad; oval when viewed from dorsal surface; profile view showed a convex dorsal and almost flat ventral surface. It possessed a pair of antennæ and two pairs of limbs. Each of the first pair of limbs was bifid, the two branches bearing long hairs at their extremity. Each of the second pair was bifid, the two branches bearing each a spinous hook at its extremity. A remarkable tail-like prolongation, fringed with pinnate hairs, was then described. The curved intestinal canal, the eye spots, and the pigment masses within the visceral chamber, were then adverted to.

2. Memoir of the Life and Writings of Robert Whytt, M.D., Professor of Medicine in the University of Edinburgh, from 1747 to 1766. By William Seller, M.D., F.R.S.E., F.R.C.P.E.

Biography, the author said, had never done sufficient justice to Robert Whytt, while it began already to omit his name. Whytt had commonly been represented as a follower of Stahl; and this idea, which was without foundation, had probably been a principal cause why his merits had not always been duly recognised.

It was mentioned in the Memoir, that Whytt was born at Edinburgh, September 6, 1714; he was the son of Robert Whytt of Bennochy, a member of the Scottish bar; he was a posthumous child, born six months after his father's death; he was not yet seven years old when he lost his mother; her name was Murray; she was the daughter of Antony Murray of Woodend, in Perthshire. Whytt was sent, when still very young, to the University of St Andrews, where at the early age of sixteen he took the degree of Master of Arts. When fourteen years old he succeeded, by the death of his elder brother, to the family estate. He had two sisters, who were married, and had descendants. In 1730 he repaired to Edinburgh to study medicine; and there is still extant a manuscript book of notes taken by him at that period from the lectures of George Young. After three or four years devoted to medicine at Edinburgh, he proceeded to London, where he became the pupil of Cheselden; thence to Paris, where he studied anatomy under Winslow; and thence to Leyden, where Boerhaave and Albinus were his preceptors. Finally, in 1736, he took the degree of Doctor of Medicine at Rheims. On his return to Scotland the University of St Andrews spontaneously conferred on him the same medical honour. Having become a fellow of the Edinburgh College of Physicians, he commenced practice, and even at so early an age he is said to have had much success. Soon after he married Miss Robertson, who is described as the sister of General Robertson, Governor of New York. By this lady he had two children, who died in infancy. Her death followed soon after. In 1743 he married Louisa Balfour of Pilrig, whose brother afterwards became Professor of Moral Philosophy in the University of Edinburgh. By this lady he had fourteen children, six of whom survived him. His second wife died in 1764, two years before himself. Whytt suffered severely from ill health for fifteen months before his death, which took place, April 15, 1766. A post-mortem examination showed extensive effusion in both cavities of the pleura, some disease in the mucous membrane of the stomach, and concretions in the pancreas.

Whytt's first work, "On the Virtues of Lime-Water and Soap in the cure of Stone," was published in the Edinburgh Medical Essays for 1743. It subsequently went through several editions, and was translated into French and German. Though time has rendered a great part of this work obsolete, it still merits a distinguishing mark in the history of science, since Dr Black has left it recorded, that it was the controversy between Whytt and Alston respecting the most solvent kind of lime-water, which led him to the examination of calcareous earth, magnesia, the alkalies, and fixed air, whence he obtained conclusions that placed chemistry within a short period of their date on a wholly new and extended footing.

Whytt's next work, published in 1751, "On the Vital and other Involuntary Motions of Animals," fixed the attention of physiologists throughout Europe on its author. His more practical work "On the Sympathy of Nerves and on Nervous, Hypochondriac, or Hysteric Disorders," published in 1764, is a commentary on the former, and a practical illustration of its doctrines. Whence in the present summary both works are considered together, though in the Memoir itself each work is separately treated of.

The first object of the Memoir, under this head, is to show by sufficient proofs that Whytt was not a follower of Stahl,—that he was no more an Animist or Semianimist, than the major part of physiologists at the present moment,—that while Whytt conceived it more conducive to simplicity to represent his sentient principle as a part of the soul, he expressly declares it to be superfluous to dispute with any one who holds doubts thereon, because all his views are independent of that idea, and possess the same truth, whether the sentient principle be or be not accounted a part of the soul. Further, that this sentient principle being destitute of reason, intention and consciousness is really nothing but a physiological force, united with the nervous centre, susceptible of being so far excited by impressions brought by the afferent nervous fibrils, as to communicate motor force to the efferent nervous fibrils which proceed to contractile organs. That such is exactly the light in which Cullen places Whytt's doctrine, referring to Whytt's own expression, that under the appropriate impressions, the power is as certainly determined to bring about these motions, "as is a scale which, by mechanical laws, turns with the greatest weight." That notwithstanding the denial of any consciousness in the case, it is true that the term sentient, and the quality of ungratefulness ascribed to the impressions concerned, create a confusion of ideas; but that that difficulty had its source in the want of appropriate words (greater in Whytt's time than now) to express the effect of physical agents on organic tissues. That there has always prevailed in physiology a tendency to express in a term not merely the property, but the cause of that property, which is exemplified in the contrast between the nearly synonymous words contractility and irritability,—the former signifying nothing more than the susceptibility of contraction, while the latter, the older word, bears reference to the cause of that susceptibility. That the idea attached by Whytt to "sentient principle," while he denies that it involves consciousness, may be gathered by some consideration of what dwelt in Glisson's mind, when, speaking of the obvious effect of impressions on the spinal cord in animals after decapitation, he says the cord perceives without sensation.

The Memoir referring to the contrast between the effect of a drop of boiling water suddenly falling on the naked foot, and the effect of the sight of a drop of boiling water about to fall on the naked foot, points out that in the latter case the foot is moved by an intelligible force, namely, a volition, but in the former case, by a latent force, which is what Whytt calls his sentient principle. Further, if it be said, why introduce any force, sentient or not sentient, where nothing is by any research discoverable, that Whytt felt himself obliged by the usage of his age to invent an hypothesis, that some force might seem to intervene between the impression on the afferent nerve and the motor power imparted to the efferent nerve; and that if he had felt himself at liberty to omit this hypothesis, his view would have been in general terms exactly that of the present day,—namely, that impressions made on the peripheral extremities of afferent nerves are reflected through the nervous centre into motor influence, transferable by efferent nerves to contractile organs. Again, that the modern view does not reject the idea of a force intervening between the impressions and the reflected motor influence, but merely omits all mention of it, because the connection between the impression and the subsequent motion is not spoken of in relation to cause and effect, but merely as the observed law of an antecedent and consequent, whence that Whytt's mode of thinking does not in general terms differ from the modern view, except that he attempted to solve a difficulty which the modern view declines to meddle with.

The Memoir, however, affords another reason why Whytt felt obliged to interpose an active cause between the impression on the afferent nerve and the motor influence in the efferent nerve, inasmuch as no consistent attempt had then been made to assign separate offices to particular parts of the nervous centre; and the idea that a part of the tissue of the nerves and brain (such as the white fibres in both), might be merely conducting cords, while another part, such as the grey substance, might be the exclusive origin of force, had not then arisen, whence, as he himself states, that his view was unsatisfactory to explain why an afferent nerve bringing an impression from an external part to one point of the nervous centre, should have its effect reflected into an efferent nerve arising at a distant point of the same centre, unless some influence pervading the whole nervous centre, and therefore the space between the two nerves, were the exciting force, such as his sentient principle.

The Memoir further shows, that though Whytt did not attempt to assign separate offices to separate parts of the nervous centre, understood as including the encephalon and spinal marrow, yet, when explaining the movements in decapitated animals, he suggests the idea that the spinal cord may be capable of independent action, as in tortoises, which live months after being deprived of the brain; while it also affords proof that though Whytt made no pretensions to improve the anatomy of his age as respects the nervous system, he was the authority referred to for seventy years for the hypothesis now recognised as an important fact,—namely, that the ultimate fibrils of the nerves, amidst all their combinations into cords, plexuses, and the like, pass unbranched and isolated from their origin to their termination. Again, it is maintained that this hypothesis could not fail by a single step to suggest the division of the nervous system into conducting cords and centres of force, and therefore to lead to the perception of the probable analogy between the ganglionic system in the invertebral animals and the nervous centre in the vertebrata.

The sum of Whytt's view is next exhibited in the Memoir in contrast with the matured state of the same doctrine in the present day, in as far as regards the non-vital involuntary movements,—viz., the closing of the pupil under a strong light; the shutting of the eyelid when the eye is threatened; the adjustment of the membranes of the internal ear by the muscles of the tympanum to the variations of sound; the act of respiration, and its modifications, sneezing, cough, hiccup, vomiting, deglutition, the evacuation of the bowels and bladder, and such acts as the sudden withdrawal of the foot when a drop of boiling water falls on it. It is further shown that in such acts generally, there is a consciousness of the impression and a consciousness of the muscular act determined by it, but that there is no consciousness of the exercise of any intervening power, or of the effect of what Whytt terms the sentient principle. It is further stated, that while the discovery of numerous before unnoticed relations between the several parts of the nervous system has largely explained the conformation of the nervous organism, there has not been a corresponding advance in the knowledge of the activities therein operative, so that the same forms of expression are applicable to Whytt's system and to the matured state which his views have now assumed.

The Memoir goes on to state that Unzer was the first who followed Whytt in such a mode of considering nervous action; that while it is acknowledged that Unzer's book is one of great ability, it is a mistake to think that his reflex action of nerves is an advance upon Whytt's,—that it is, on the contrary, retrograde, as the reflex action which he describes is made dependent on communications of nerves in their course analagous to the explanation given by Willis of sympathy. That Prochaska did make a considerable advance; that reflex action in his hands has its seat in the common sensorium or cranio-spinal axis, or excludes the cerebrum and cerebellum, while he describes it as a law written on the medullary pulp of the sensorium,—that is, he ascribes it to no principle or force, though his expression implies the latent existence of such a principle or force. That Marshall Hall is entitled not only to the credit of having given a new impulse to the study of this part of physiology, but of having made the great advance of showing that each segment of the spinal cord and *medulla oblongata* possesses a separate power of imparting reflex action to the nervous fibrils which originate in it, whenever certain impressions are brought to that segment by afferent nerves which terminate there.

In reference to Whytt's views of sympathy which belong to the second of the works mentioned before, his sympathetic actions come under the same head as the non-vital involuntary motions, or depend on impressions reflected into motions through the nervous centre. The sympathetic sensations are either the result of mental states acting on the nervous centre, and thence on nerves of sense, or sensations produced through one set of nerves reacting on other nerves of the same character. The latter idea is manifestly the same as what in modern times has been termed the radiation of sensation.

With respect to Whytt's controversy with Haller, and the several papers published thereon, it referred to the dependence or non-dependence of irritability, now termed contractility, on nerves,—the former opinion being maintained by Whytt, the latter by Haller. This subject was largely experimented on by Whytt, whose mode of thinking gained many converts in his own time and in subsequent years. It has happened, however, that Haller's views in this particular prevail at the present time, with this understanding,—that though the contractility of the organs concerned in the vegetative functions is not regarded as dependent on nerves, yet the organs of all such functions are believed to be very largely modified by an influence derived from nerves.

As the Memoir itself is of considerable length, and is mainly devoted to the elucidation of the two works above referred to, what has just been said gives but an imperfect idea of the entire character of these principal works of Whytt.

The Memoir concludes with some notice of his other papers, and in particular with a short view of his posthumous work on acute hydrocephalus, on which, in several particulars, he is an original authority.

3. On a difficulty in the Theory of Rain. By James Dalmahoy, Esq.

The difficulty which the paper discusses is the paradoxical fact discovered by Dr Heberden,—namely, that if there be three exactly similar rain-gauges, and one of them be placed on the ground, the second on the roof of a neighbouring house, and the third on a still higher edifice, then, notwithstanding every variety in the positions of these gauges as respects surrounding objects, and notwithstanding the prevalence of the opposite conditions of high wind and of absolute calm, it is observed that the lowest gauge receives more rain than the middle one, and the middle gauge more rain than the upper one.

The paper endeavours to show the inadequacy of the explanations which have hitherto been given of this difficulty, and quotes, on this point, the authority of Sir John Herschel. It then proceeds to prove, both theoretically and by observation, the existence of a slow downward current of air mingled with minute globules of water, the current itself being the effect of the rain, and originating in the cloud from which the rain proceeds. The twofold agency of this downward current in producing the paradoxical results is then explained; and the paper concludes with a numerical estimate, the object of which is to prove that the quantity of water which it is necessary to assume as being contained in a given volume of the atmosphere, *at a given time*, in order to account for even the more remarkable results on record, is too small to give rise to the appearance of cloud; and so, by proving this, to obviate what would otherwise have been a formidable objection to the proposed explanation of the phenomenon.

4. On the Structure of the Bark of *Araucaria imbricata*, with special reference to Palæontology. By John Hutton Balfour, A.M., M.D , F.R.S., Sec. R.S.E., Professor of Medicine and Botany.

The frost of December 1860 caused serious damage to trees and shrubs in the Botanic Garden of Edinburgh. On the morning of 24th December, Fahrenheit's thermometer stood at 6° below zero, according to the Kew standard. An account of the injury inflicted has been already published in the Transactions of the Botanical Society of Edinburgh. It has been stated that the great cold in the garden, as compared with other places near Edinburgh, may be accounted for by its low sheltered situation, and the descent of the heavy cold atmosphere from the more elevated localities around.

Among the plants which suffered were two very fine specimens of *Araucaria imbricata*, which had stood for upwards of thirty years, and one of which had attained the height of 24½ feet, with a circumference of 4 feet at the base of the stem, and with twenty whorls of branches. These trees, which were great ornaments of the lawn in front of the range of hothouses, have been cut down. An opportunity was thus afforded of examining the structure of their wood and bark. The former is very hard and heavy, and promises to be valuable timber. In regard to the latter, the scars and markings, and their relation to the leaves, seem to deserve special notice. The sharp-pointed triangular hard and spirally arranged leaves are remarkably persistent. None of the plants in the garden have ever shed their leaves. They become sometimes of a brown colour; but even then they continue to adhere to the stem, and appear as unsightly appendages. In one of the plants cut down the leaves show a splitting at the base, apparently from distension in the parts underneath, similar to what takes place in the petioles of many palms before they are detached. It is possible that, in the Araucaria, the splitting of the basis of the leaves may sometimes be the precursor of their fall. From the lower part of the leaves prolongations extend along the surface of the bark, and give rise to peculiar markings, which are well seen when the leaves are cut off close to their union with the stem (fig. 1). The base of the leaf remaining in the bark has the form of a narrow elongated ellipse, surrounded by cortical foliar prolongations. The markings on the bark, viewed externally, have a somewhat oblique quadrilateral form. The leaves, when examined by the microscope, show stomata on both surfaces, running in lines, not unlike the appearance presented by stomata in Equiseta.

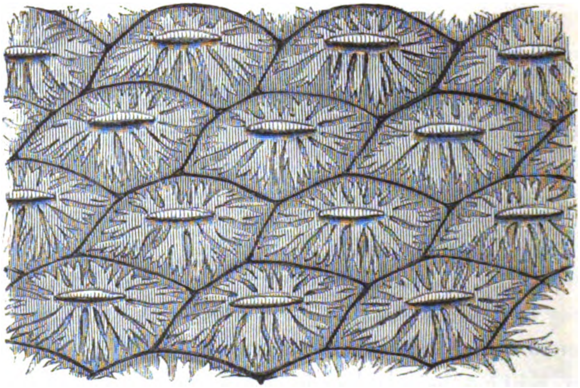

Fig. 1.

On removing the epiphlœum or outer bark, and examining its inner surface, we remark a difference in the appearance presented at the lower and upper part of the stem. In the lower portions the markings have an irregular elliptical form, with a deep depression, and fissures where the leaves are attached (fig. 2). Higher up the epiphlœal markings assume rather more of a quadrilateral form, with the depressions less deep, and the fissures for the leaves giving off prolongations on either side. Farther up the markings are smaller in size, obliquely-quadrilateral, and present circular dots along the boundary lines chiefly (fig. 3). Higher still the quadrilateral form becomes more apparent, and the dots disappear (fig. 4). The epiphlœum thus presents differences in its markings at different heights on the stem.

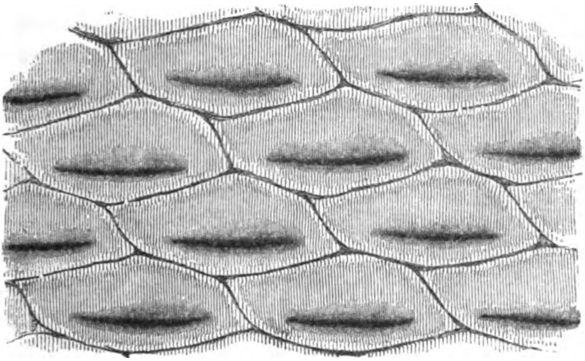

Fig. 2.

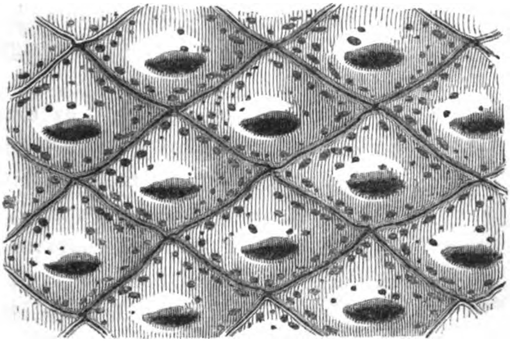

Fig. 3.

The middle part of the bark, or mesophlœum, is well developed, and is of a spongy consistence. When examined microscopically it is seen to be composed of cells of various shapes—some elongated fusiform, others rhomboidal, others with pointed appendages. The variety of forms is very great, and it is possible that this may be partly owing to the effects of frost on the cells. On the spontaneous separation of the bark, the mesophlœum was seen to consist of distinct plates of a more or less quadrilateral form, with some of the edges concave and others convex, a part in the centre indicating the connection with the leaf, along with which it is detached. In Fig. 5 a leaf is shown with a mesophlœal plate attached.

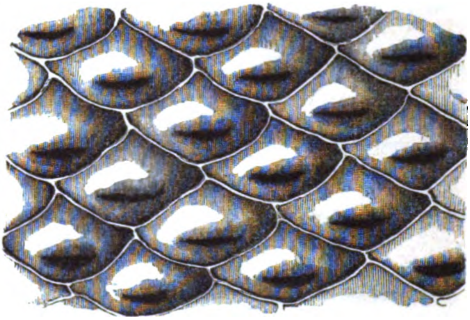

Fig. 4.

The endophlœum, liber or inner bark, is of a fibrous nature, and consists of elongated woody tubes.

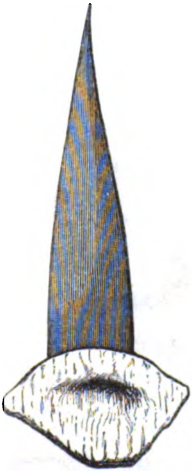

Fig. 5.

The appearances presented by the outer and middle bark of *Araucaria imbricata* bear a marked resemblance to those exhibited by certain fossils included in the genera Sigillaria and Lepidodendron. The sculpturesque markings on the stems of these fossil plants have induced geologists to look upon them as allied to the ferns and lycopods of the present epoch. But it is evident, from the specimens of Araucaria now laid before the Society, that much caution is required in making this determination. Other points of structure must be examined before a proper decision can be formed; when, for instance, the presence of scalariform tissue, or of punctated woody tissue has been satisfactorily shown under the microscope, we are entitled to hazard an opinion as to the affinities of the fossils. In many instances, however, external appearances are the only data on which to rely for the determination of fossil genera and species; and rash conclusions have often been drawn by geologists who have not been conversant with the structure of plants.

The Araucaria markings point out the need of care in drawing conclusions, and their variation at different parts of the bark indicate the danger of a rash decision as to species. There can be no doubt that in vegetable palæontology the number of species has been needlessly multiplied—any slight variation in form having been reckoned sufficient for specific distinction. We can conceive that the Araucaria bark markings in a fossil state might easily supply several species of Sigillaria, or of Lepidodendron. The geologist, with little knowledge of the present flora of the globe, ventures often to decide on an isolated fragment, which a well-informed botanist would hesitate to characterise. Hence the crude descriptions of fossil vegetable forms, and the confusion in which Palæophytology is involved. Every geologist who examines fossil plants ought to be well acquainted with the minute structure of living plants, the forms of their roots, stems, leaves, fronds, and fructifications; the markings on the outer and inner surfaces of their barks, on their stems, and on their rhizomes; the localities in which they grow, and the climates which genera and species affect in various parts of the world.

The following Gentlemen were elected Ordinary Fellows:—

EDWARD FRANCIS MAITLAND, Esq., Advocate, Solicitor-General for Scotland.

Rev. ROBERT BOOG WATSON, late Chaplain to the Forces.

The following Donations to the Library were announced:—

Proceedings of the Royal Society of London. Vol. XI. No. 48. 8vo.—*From the Society.*

The Journal of the Chemical Society. Vol. XV. Part 3. 8vo.—*From the Society.*

Proceedings of the Royal Horticultural Society. Vol. II. No. 4. 8vo.—*From the Society.*

The Assurance Magazine and Journal of the Institute of Actuaries. No. XLVII. 8vo.—*From the Institute.*

Almanaque Náutico para el año 1863. Calculado de órden de S. M. en el Observatorio de Marina de la Ciudad de S. Fernando. Cadiz, 1861. 8vo.—*From the Director of the Observatory.*

Pocket Diagram of Mean Pressures of Expanding Steam. By W. J. Macquorn Rankin, C.E., LL.D.—*From the Author.*

London University Calendar for 1862. 12mo.—*From the University.*

Monday, 21*st April* 1862.

PROFESSOR CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. On the Theory of Numbers. By H. Fox Talbot, Esq.

2. On the Carboniferous Volcanic Rocks of the Basin of the Forth. By Archibald Geikie, Esq., F.R S.

After referring to a previous communication to the Society, in which the author had given an outline of the chronology of the igneous rocks of Scotland, he proceeded in the present paper to describe in detail the character of the volcanic phenomena in one district—that of the carboniferous system of the Forth basin. The igneous rocks of this district consist partly of doleritic and felspathic lava-form masses, and partly of various kinds of ash or trap-tuff. These materials present a considerable diversity in their modes of arrangement. But the author had found that all the volcanic hills of the district might be reduced to three types of structure:—1. A simple cone of ash, round and over which the ordinary sedimentary accumulation of the carboniferous period had been deposited. 2. A cone of ash with the crater filled up by a neck or plug of basalt. 3. Sheets of different lavas with intercalated ash or sedimentary matter.

He described in detail the succession of volcanic phenomena in the Lothians and in Fife, pointing out how local and limited the eruptions had been as a whole. They were confined to the earlier half of the carboniferous period, no interbedded igneous rock having yet been found in the formations that overlie the carboniferous limestone. The whole of this district appears to have been dotted over with volcanic cones, from each of which independent eruptions took place. To such a kind of scenery the nearest parallel in Europe is probably the region of Auvergne and the Haute Loire, which the author had recently visited for the purpose of comparison. The concluding part of the paper was devoted to a sketch of the subterranean movements of upheaval and depression which can be shown to have taken place during the volcanic period in the basin of the Forth, and to some remarks on the abundance of life in the immediate vicinity of the volcanic orifices.

3. On the Constitution of Society in this Country, with reference to the Proportion which Male Life bears relatively to Female Life, and the Effects of an Excess of Female Life. By W. T. Thomson, Esq.

The object of this paper is to show the prejudicial effect which the excess of females has upon the condition and moral well-being of society in this country.

Excess of Males at Birth.

" According to the Twenty-Second Annual Report of the Registrar-General of *England* for 1859 (published in 1861), 689,881 births were registered in that year, viz.—

Male Children, ...	352,662
Female Children, ...	337,219
Total, ...	689,881

that is, 104·58 males to 100 females.

Of these there were born—

In wedlock, . . .	329,668 males,	315,462 females.
Out of wedlock, .	22,994 ,,	21,757 ,,
	352,662	337,219

showing 105·7 males born in wedlock, to every 100 females so born, and 104·5 males born out of wedlock to every 100 females so born."

"According to the Second Annual Report of the Registrar-General for Scotland for 1856 (published in 1861), 101,821 births were registered in that year—

Male Children, ...	52,239
Female Children, ...	49,582
	101,821

that is, 105.3 males to 100 females.

Of these there were born—

	Males		Females	
In wedlock, . .	47,761	males,	45,365	females.
Out of wedlock, .	4,478	„	4,217	„
	52,239		49,582	

showing 105·28 males born in wedlock to every 100 females so born, and 106·19 males born out of wedlock to every 100 females so born."

"The proportion between male and female births is found by observation not to differ at any time materially from the results here quoted for a single year, although the variation in different localities is peculiar; and there is, it will be perceived, an unexplainable difference in the relative proportions among legitimate and illegitimate children."

Excess of Females in Life.

"It would naturally be inferred from these facts, so many more males being born than females, that male life preponderated both in England and Scotland; but the state of the entire population, as shown by the census of 1851, will exhibit conclusively that, whatever may have been the relative proportions at birth, the actual condition of the country, comparing males with females, is very different in its results."

Population of England and Wales at the Census in 1851.

	1851.	
	Males.	Females.
England and Wales, . . .	8,781,225	9,146,384
Scotland, ...	1,375,479	1,513,263
Islands in the British Seas, . .	66,511	76,405
	10,223,215	10,736,052

"Here the great fact is exhibited that there were about 4·2 per cent. more females than males in England, 10 per cent. more females than males in Scotland, and nearly 15 per cent. more females than males in the Islands in the British Seas in 1851; while, in 1861, the per-centage had increased to 5·57 more females than males in England, 11·56 per cent. more females than males in Scotland.

"With these facts before us, it requires no lengthened proof to satisfy the most casual observer that the great design of Providence in providing a larger number of males than females has been frustrated."

"This abnormal state of society has arisen chiefly from two causes:—

> The greater mortality of male life as compared with female life, more particularly in early years, and
>
> The emigration of a larger number of males than females."

"I shall now endeavour to prove that these causes of disorganisation exist."

The greater Mortality of Male Life.

[Mr Thomson here exhibited a table showing the population, deaths, and mortality generally in England and Wales from 1838 to 1844, a period during which the mortality was not disturbed by epidemics.]

"It will be perceived," he proceeded, "that from birth to five years of age, male children died during the seven years at the rate of 7·072 per cent., and female children at the rate of 6·037 per cent., the actual numbers dying having been 517,897 males and 446,910 females. From five to ten years the difference was not so great between the sexes, 61,659 males to 59,903 females. From ten to thirty-five (the principal period of child-bearing) the female mortality was somewhat greater. The male mortality then increased, and continued greater till the close of life."

"The feature which first attracts attention in considering these results is the great mortality in the early years of male life. 70,000 male children were lost during the first five years of life, that being the excess of male deaths as compared with the deaths among females. Similar results will be found to obtain year by year in other years, according to the reports of the registrar, and such a loss cannot fail to have a most prejudicial effect on the condition of society; it not only drains away the natural excess of males provided by God's providence, but, by the greater mortality of males, an excess of female life is left prejudicial to the wellbeing of females themselves, and of males also. It is impossible that this infringement of the laws of nature can lead to any but one result—it has led to immorality and suffering, and will continue to do so; for it is not for one moment to be supposed that it was the intention of the Deity to create male children in excess to be swept away within a few years after entering life. But, indeed, the excess of male deaths is not the sole measure of evil, for no doubt female mortality is also greater than it should be; and, in like manner, the male deaths, were they only equal to the female deaths, would also be greatly in excess of what they should be. It is a sad state of matters—a national calamity, and demands attention."

" Again, above thirty-five years of age to the end of life, the male deaths bear an unfavourable comparison with the females. Men sink exhausted, worn out, leaving widows and young children to increase our difficulties. The loss of infant life is a great evil, but the loss of man in the prime of life is a greater. No one can fill the father's place in a poor man's home; his death is frequently an immediate fall from competence to destitution. The struggle is for existence, and children are brought up, if reared at all, weak in body and mind, oftener indeed cut off by disease, helping to fill up in rotation the death-roll of our Juggernaut, which year by year demands its sacrifice. If they survive, the want of means denies them education, and they are often left a legacy to fill our jails and poor-houses. A few years added in the aggregate to male lives would create a great change in all this; widows would be reduced in number, and many children now thrown helpless on the world would be supported and educated in their earlier years. Our unnatural position acts and reacts to our disadvantage, and the excess of male deaths at the periods shown is an ever fruitful source of sin and misery."

" If this is bad in England, it is worse in Scotland. That country has many other difficulties also to contend with peculiar to its position; but as I afterwards propose to limit my observations to that country, I shall reserve further remark."

In order to prove that the increased death rate among males was not increased by special or local causes, Mr Thomson introduced a table showing that the results over the whole of England are much the same, exhibiting a greater mortality almost universally among the male sex.

Also a table taken from the returns of the Registrar-General, exhibiting the per-centage of deaths among males and females during twenty years, with the relative proportions which these deaths bear to each other, proving at the same time that the greater mortality among male lives is constant.

These tables proved conclusively the first proposition, that the mortality of male life is greater in England than that of female life. Mr Thomson then proceeded to show what causes have produced these results:—

Deaths of Males and Females in England during the year* 1858.—*From the Registrar-General's Twenty-first Report.

	Males.	Females.	Excess Males.	Excess Females.
I. **Zymotic Diseases.**				
Miasmatic.—Small-pox, Measles, Scarlatina, Fevers, &c., ...	52,325	53,953	...	1,628
Enthetic.—Syphilis, Stricture of Urethra, &c.,	698	497	201	...
Dietic.—Privation, Want of Breast Milk, Alcoholism, &c., ...	1,304	808	496	...
Parasitic.—Thrush, Worms, &c., . .	745	641	104	...
	55,072	55,899	861	1,628
II. **Constitutional Diseases.**				
Diathetic.—Gout, Dropsy, Cancer, Noma, Mortification, ...	6,440	10,350	...	3,910
Tubercular.—Scrofula, Tabes Mesenterica, Phthisis, &c., ...	32,035	33,591	...	1,556
	38,475	43,941	...	5,466
III. **Local Diseases.**				
Diseases of Nervous System.—Cephalitis, Apoplexy, &c., ...	28,841	25,120	3,721	...
Organs of Circulation.—Pericorditis, Heart Disease, &c., ...	8,086	8,340	...	254
Respiratory Organs.—Laryngitis, Bronchitis, Pleurisy, &c., ...	34,672	30,844	3,828	...
Digestive Organs.—Gastritis, Enteritis, Peritonitis, &c., ...	9,449	9,797	...	348
Urinary Organs.—Nephritis, Ischuria, Kidney Disease, &c., ...	3,332	1,351	1,981	...
Organs of Generation.—Ovarian and Uterine Disease, &c., ...	53	1,095	...	1,042
Organs of Locomotion.—Arthritis, Joint Disease, &c., ...	675	489	186	...
Integumentary System.—Phlegmon, Ulcer, Skin Disease, &c., ...	697	648	49	...
	85,805	77,684	9,765	1,644
IV. **Developmental Diseases.**				
Congenital Malformations and Developmental Diseases of Children, ...	6,884	5,528	1,356	...
Developmental Diseases—Adults.—Childbirth, &c., ...	...	2,114	...	2,114
Developmental Diseases—Old People—Old Age,	11,954	16,555	...	4,601
Diseases of Nutrition.—Atrophy and Debility,	13,954	12,906	1,048	...
	32,792	37,103	2,404	6,715
V. **Violent Deaths.**				
Accident or Negligence, ...	9,182	3,341	5,841	...
Homicide, Murder, and Manslaughter, .	215	129	86	...
Suicide.—Gunshot Wounds, Cut, Stab, Poison, Drowning, &c., ...	921	354	567	...
Execution.—Hanging, ...	9	...	9	...
	10,327	3,824	2,824	...
VI. **Sudden Deaths.**—*Causes not ascertained,*	1,826	1,270	556	...
VII. **Causes not specified or ill-defined,**	2,923	2,715	208	...
	227,220	222,436	20,237	15,453

" The diseases of which men die in greater proportion than women, thus appear to be those which arise from exposure, bad habits, overwork of mind and body, accidents, violent deaths; while the male infant seems to have an unaccountable tendency to fatal diseases, which are less destructive in the female child."

(The author here introduced a table, showing the causes of death in Scotland at different periods of life, under ten years, from all diseases, in 1856.

This table showed an excess of male deaths at every period of age, and by every one of the diseases specified, viz:—

Zymotic Class,
Diseases of Uncertain Seat,
Tubercular Class,
Brain—Nervous System,
Organs of Circulation,
Respiratory Organs,
Organs of Digestion,
Urinary Organs,
Organs of Generation,
Organs of Locomotion,
Skin, &c.
Malformation,
Premature Debility,
Atrophy,
Age,
Sudden Deaths, and
Violent Deaths.

the total result being 14,053 male deaths to 12,314 female deaths under ten years of age.)

" The principal diseases which occasion death in children," Mr Thomson continued, " are zymotic diseases, diseases of respiration and digestion, tubercular diseases, and general debility; but there seems to be nothing yet known connected with the principal causes of death that can account for a greater mortality among male children than among female.

" On this part of the subject I shall not dwell, the facts are sufficient for my purpose in this paper. I have given one table of diseases from English observation, and the other from Scotch observation, to show the identity of result in both countries."

The Emigration of a larger Number of Males than Females, and Excess of Male Life in the Colonies.

" There is no want of proof under this head. but I must endeavour to make that proof so conclusive, that there can be no question on the point. I shall therefore take my figures entirely from Government sources, and leave them to speak for themselves."

(Here Mr Thomson exhibited a table which proved distinctly the immense loss to this country of male life which has taken place in consequence of emigration—the total loss having been 272,416 males during the ten years 1848 to 1857 in excess of females, and upwards of 40,000 in 1858, 1859, and 1860—men generally, if not invariably, in the prime of life, full of health and strength.

The total of emigration from the United Kingdom during these ten years was stated to be 1,443,382 males and 1,183,430 females, besides 125,956 whose sex was not distinguished. Also, that in 1858, 1859, and 1860, the male emigration amounted to 202,347 persons, and the female emigration to 159,424 persons.

Mr Thomson illustrated this point still further by reference to the population of different colonies.)

Return showing the Population of New South Wales, 1821 *to* 1857 :—

Year.	Males.	Females.	Gross Population.
1821 . . .	21,693	8,090	29,783
1828 . . .	27,611	8,987	36,598
1833 . . .	44,688	16,173	60,861
1836 . . .	55,539	21,557	77,096
1841 . . .	87,298	43,558	130,856
1846 . . .	114,769	74,840	189,609
1851* . . .	106,229	81,014	187,243
1856 . . .	147,091	119,098	266,189
1857 . . .	171,673	133,814	...

"In 1851 there was a deficiency of 252 females to every 1000 males. Proportion, 56·8 males to 43·2 females."

"In 1856 there was a deficiency of 208 females to 1000 males. Proportion, 55·2 males to 44·8 females."

Total Population of New South Wales—1856.

	Under 14.	14 to 60.	60 and Upwards.
Males . .	50,276	91,739	5076
Females . .	49,982	67,104	2012
Excess of Males	294	24,635	3064

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* Separation of Port-Philip in this year causes decrease.

Victoria.

	Males.	Females.
1854 . . .	155,876	80,900
1857 . . .	264,334	146,432
1857 (ages 20 to 40)	84,790	34,843
1858 (office returns).	308,983	176,786
1860 . . .	341,628	203,049

"Tasmania, again, according to the population returns of 1857, shows the following results:—

Males . .	45,916
Females . .	34,886
Excess of Males .	11,030, or 24 per cent.

Ages 21 to 45, males 20,913, females 13,610.

New Zealand, 1857 .	Males 29,435	Females 22,720.
Western Australia, 1857	Males 9028	Females 4573."

(The following extract was given from the Twentieth General Report of the Emigration Commissioners, 1860, regarding the disparity of sexes in Victoria, showing distinctly that the evil produced at home by emigration was productive of serious evil in the colony:—)

"The census of 1857 discloses some remarkable facts respecting the disparity of sexes in Victoria, which is thus noticed by Sir Henry Barkly in his despatch transmitting a portion of the tables.

"It now appears that, though considerable improvement in this respect took place between 1854 and 1857, yet that the effective disproportion at the latter period was far more serious than would be deducible from the fact of there being 163 males to every 100 females in the entire population. Since tabling the portion of it above the age of twenty years there were no less than 217 males to that number—the proportions below that age being pretty nearly equal.

"The effect of this disparity may be more clearly deduced from the tables relating to the conjugal condition of the people, which show that there were 88·355 unmarried men of twenty years of age and upwards to but 12·545 unmarried women of corresponding ages; or, to raise the age of marriage for men to twenty-one, and lower it to fifteen for women, there was still an excess of 61,859 bachelors, not to add 5112 widowers.

"Even this comparison, however, fails to convey a full sense of the evil as it affects the gold fields, where it appears that the percentage of unmarried men is to that to be found in the seaport towns as 61 to 39; or, to state the case in another form—where the bachelors are to the spinsters in the proportion of more than 20 to 1. There are, moreover, 8096 married men, chiefly in the mining districts, whose wives are not in the colony."

"It is no doubt true that this excess of male life is all above a certain age, according to the age of the colony, the deficiency of females having arisen from the greater emigration of males originally; and it is to be admitted, that as the native growth of population increases, a normal state of life with reference to the proportion of males and females will arise; but in the meantime it occasions great social evils, which afflict most severely the mother country."

General Results.

(Mr Thomson here exhibited an elaborate table showing the relative proportions of males and females of twenty years of age and upwards in England and Wales taken from the census of 1851; also the proportion of births, marriages, and deaths to 100 persons living, likewise children born out of wedlock to 100 births throughout each county.)

"There are curious variations in the results shown in different counties and districts, and east, west, north, and south, yield very different proportions; but the grand total for England and Wales may be read thus:—

For every 100 males there were 108·11 females in England and Wales at the census of 1851.
For every 100 bachelors 101·13 spinsters.
For every 100 husbands 101·31 wives.
For every 100 widowers 198·18 widows.
For every 100 persons living there were (1850 to 1857) 3·399 births.
For every 100 inhabitants there were (1857) ·824 marriages.
For every 100 persons living there were (1857) 2·175 deaths.
And out of every 100 births there were (1857) 6·5 children born out of wedlock.

" It will be found, when we afterwards come to consider the results in Scotland, that female life is very greatly in excess of male life proportionally as compared with England; that the unmarried females and widows are in much larger proportion; and that illegitimacy prevails to a wider extent—the result of the comparison being that there is more illegitimacy where there is a greater excess of female life; but, although I draw this general conclusion, I cannot, in considering the table referred to above, or the table applicable to Scotland which follows, prove in detail that in every county where there is an excess of females there is an excess of bastardy. I must ask my readers to take the wider view of our condition, and deal, as a whole, with the comparative effects, for there are many acting and reacting influences in operation in particular localities which produce results very different from those we anticipated. We must mass the results, and the comparison of Scotland and England is on a sufficiently large scale to give us confidence in our conclusions.

" As an example of the difficulty of drawing conclusions from limited or local facts, let us consider London. We find there 120·53 females for 100 males, 125 spinsters to 100 bachelors, and 296·86 widows for 100 widowers, with only 4·2 children born out of wedlock to 100 births. The hasty conclusion would be, that London is more moral than the whole of England, for we find, in running our eye down the bastardy column, that the return of illegitimate children is less than for any county in England, and more than 2 per cent. less than the average for the whole kingdom. I am afraid that that conclusion will not stand investigation. I do not mean to say that the solution of the problem is an easy one, but I do not think the deduction, based on a purer morality, is correct. It is more than probable that the great prevalence of prostitution has the effect of diminishing child-bearing among unmarried persons; and I have no doubt that every large town will show the same result."

" I have now shown—

" 1. That the male births exceed the females in a certain proportion, which, in the state of this country, may be called a constant ratio, or, in modern scientific language, ' an ultimate statistical unit,' if there be such a thing.

" 2. That males die more rapidly than females, more particularly in early life.

"3. That males emigrate in larger numbers than females.

"4. That the amount of female life in this country exceeds the amount of male life."

Scotland.

"I will now confine my remarks to Scotland, as it is to the state of that country I wish more particularly to direct your attention, and the contrast afforded by the following figures will serve as a very proper introduction to my remarks:—

			In England and Wales.	In Scotland.
Total	Females to 100 males, .	Census 1851,	108·11	121·00
,,	Spinsters to 100 bachelors,	do.	101·13	123·63
,,	Wives to 100 husbands,	do.	101·31	102·26
,,	Widows to 100 widowers,	do.	198·18	271·13
,,	Births to 100 persons living,	Years stated,	3·399	3·417
,,	Marriages to 100 inhabitants,	do.	·824	·676
,,	Deaths to 100 persons living,	do.	2·175	1·977
,,	Children born out of wedlock to 100 births, .	do.	·650	·900

"We are altogether in an abnormal state. Our young men have left us; our maidens are unmarried; our widows are in excess; our wives are deserted; our marriages are deficient; illegitimacy is rampant; and from all this flow many crimes.

"After carefully considering these sad figures, and having given much attention to the Report of the Registrar-General of Scotland, my strong conviction is, that the excess of female life is mainly at the root of that great evil—illegitimacy. I have no doubt that local customs and habits increase it, and that race has something more or less to do with its extent in particular counties; but the root of all is our abnormal position, already explained. It is not very easy to separate the races which have peopled Scotland; but to those who know the appearance of the inhabitants, their customs and manners, in different parts of Scotland, it will, I think, appear a task which at least, probably, may be performed. But without attempting any minute classification, and merely keeping in view what is already known as to the settlement of the different races of inhabitants, I would simply refer to the Registrar-General's division, according to which my results are tabulated. A glance at the table will satisfy the most casual observer, that the north and west give very different results from the southern and eastern portions of the kingdom; and if the north-west and north-east alone be compared, portions of the kingdom where there has, comparatively, been little intermixture of two well-marked distinct races, the following is the result:—

	Children Born out of Wedlock to 100 Births.
North-Western, . . .	5·8
North-Eastern, . . .	15·

"I request particular attention to the following table, which has been prepared on the same plan as the table for England above referred to:—

Abstract of Table, showing the relative Proportion of Males and Females of Twenty Years of Age and Upwards in Scotland, taken from the Census of 1851; *also Proportion of Births, Marriages, and Deaths to* 100 *Persons living.*[*]

SCOTLAND.	Proportion of Females to Males. Census 1851.				Proportion of Births, Marriages, and Deaths.			Children born out of Wedlock to 100 Births, 1859.
	Total Females to 100 Males.	Spinsters to 100 Bachelors.	Wives to 100 Husbands.	Widows to 100 Widowers.	Births to 100 Persons living, 1859.	Marriages to 100 Inhabitants, 1859.	Deaths to 100 Persons living, 1859.	
Scotland . . .	121·00	123·63	102·27	271·13	3·417	·676	1·977	9·
Northern Counties .	...	...	...	...	2·521	·489	1·327	5·4
North-Western Counties	...	...	...	...	2·532	·475	1·406	5·8
North-Eastern "	...	...	...	...	3·209	·618	1·661	15·
East Midland "	...	...	...	...	3·086	·597	1·874	9·8
West Midland "	...	...	...	...	3·107	·589	1·832	7·2
South-Western "	...	...	...	...	4·249	·833	2·516	7·2
South-Eastern "	...	...	...	...	3·323	·745	1·867	8·5
Southern "	...	...	...	...	2·911	·572	1·740	13·3

Conclusion.

"Holding, then, illegitimacy to be a blot on our national character, which has been proved, and is admitted, and assuming that it is produced and increased by our abnormal condition and the other causes

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[*] The table given by Mr Thomson exhibited the results for each county.

above stated, let us at once proceed to consider what are the means which may be adopted to cure the evil and its consequences, which are so many and so grievous. I would consider the question from two points of view :—

"1. With reference to the existing excess of female life.

"2. With reference to the loss of male life.

"We have also to keep in view the question of local customs, and the habits of the people generally, as bearing on morals. The question of race, I am afraid, I must leave for further inquiry and discussion ; but I anticipate we must give the moral crown to the Celt—our Celtic race showing certainly, if we may judge from figures, a higher code of morals than the Northman and Saxon.

"The first and most obvious call, not upon Scotland, but upon the Government of the country, is to promote respectable FEMALE EMIGRATION. I am aware that endeavours have been made to do this, not only by the Emigration Commissioners, but by the colonies themselves, but it has never been attended to on a sufficiently extended scale. Both at home and abroad, comfortable 'homes,' with adequate superintendence, should be provided by the Government, and that superintendence should be by means of local committees partly composed of ladies, in correspondence with similar committees throughout the whole country. Proper matrons should accompany each ship, and pains should be taken to preserve the highest moral tone, from the time of leaving home till the final destination of the emigrants is reached. I am aware that great difficulties have arisen in carrying out such arrangements already, when tried ; but I am convinced, that under a proper system, and with the assistance of the colonies themselves, the scheme could be more effectually carried out. All ladies should take an interest in such a scheme for the sake of their sex ; and the money of the nation and its colonies should be freely expended to bring about a result, beneficial alike to the mother country and to the colonies themselves.

"In illustration of the urgent demand for females in Otago, New Zealand, I beg attention to the following memorandum, which I have received from the agent in Edinburgh for emigration to that colony, while writing this paper :—

"I think you expressed a wish, when I saw you the other day in your office, to have a statement of the population of Otago. I have looked into the matter, and the following results may be taken as correct:—

POPULATION IN 1855.

Males—European origin, . .	1562
Females— do. do., . . .	1290
Excess of males, .	272

"(The Maories or natives, present number about 56,000, are nearly all located in the North Island of New Zealand. The number in Otago stated in next table. They are rapidly dying out.)

Population of Otago, by a Census taken 31*st December* 1859.

	Males.	Females.	Total.
Europeans, ...	5150	3749	8899
Maories, or natives, . . .	238	195	433
	5388	3944	9332
Females as above, . . .	3944		
Excess of males, . . .	1444		

"The population had increased in July 1861 to about 15,000, from excess of births over deaths, but chiefly from emigration from Great Britain. I have no tables to give showing the numbers of males and females comprising this number 15,000; but I know that from the greater number of males who have passed through this office, the table, if I could give it, would show that the evil had gone on increasing in an alarming ratio.

"In July 1861 gold was discovered in Otago, which immediately caused a rush to the province from the neighbouring settlements. The gold discoveries have not as yet much affected the emigration from Britain, but I perceive signs which make me believe that a large number will leave in the spring and summer months. *Three-fourths* at least of those who leave will be males.

"From the *Otago Witness* of 23d November 1861, I extract the following table, which shows the rate at which the population of Otago is increasing:—

Passenger Arrivals at the Port of Dunedin, Otago, from 1*st July to* 30*th October* 1861.

Whence.	Males.	Females.	Children.	Total.
Hobart Town,	563	22	13	
Glasgow,	505	202	188	
London,	16	7	2	
Sydney,	684	11	13	
Geelong,	126	2	4	
Launceston,	390	8	6	
Newcastle (Australia),	131	1	0	
Melbourne,	10,765	152	85	
From parts in New Zealand,	2,161	84	38	
Adult males,	15,341	489	349	16,179
Do. females,	489	Of the children, there would be about as many girls as boys.		
Excess of males,	14,852			

"From the foregoing tables you will observe, that before the gold discoveries the males vastly out-numbered the females; while for the last three months of which I have any account, the emigration amounted to 15,341 males, and 489 females.

"I would weaken my case were I to add one word to this description.

"The industrial employment of women engages the attention of many as a remedy for existing evils.

"As I do not think there is an adequate idea abroad as to the extent to which women are already employed in this country, I think it well to give the following particulars as to the occupation or position of females, taken from the census of 1851:—

CENSUS, 1851.

Occupations of Females—Scotland.

CLASS 1.	Persons engaged in the general or local government of the country,	359
„ 2.	Persons in the learned professions (with their immediate subordinates), either filling public offices or in private practice,	80
„ 3.	Persons engaged in literature, the fine arts, or the sciences,	4,441

Class 4.	Persons engaged in the domestic offices or duties of wives, mothers, mistresses of families, children, relatives,	964,533
„ 5.	Persons engaged in entertaining, clothing, and performing personal offices for man,	205,588
„ 6.	Persons who buy or sell, keep, let, or lend money, houses, or goods of various kinds,	8,007
„ 7.	Persons engaged in the conveyance of men, animals, goods, and messages,	1,353
„ 8.	Persons possessing or working the land, and engaged in growing grain, fruits, grasses, animals, and other products,	126,041
„ 9.	Persons engaged about animals,	680
„ 10.	Persons engaged in art and mechanic productions in which matters of various kinds are employed in combination,	1,620
„ 11.	Persons working and dealing in animal matters,	17,558
„ 12.	Persons working and dealing in matters derived from the vegetable kingdom,	132,073
„ 13.	Persons working and dealing in minerals,	1,696
„ 14.	Labourers and others—branch of labour undefined,	1,901
„ 15.	Independent persons and annuitants,	16,698
„ 16.	Dependent persons,	16,885
„ 17.	Persons of no stated occupation or condition,	13,750

Note.—There were, in 1851, 659,084 females alive in Scotland below 20 years of age, and 854,179 above 20. Of these, 136,163 below 20, and 365,234 above 20, were engaged industrially; 964,533 were wives, mothers, children, and others domestically engaged; and 47,333 were annuitants, dependent persons, and persons of no stated occupation.

"It will be perceived that a very large number of females endeavour to support themselves; and I think it probable they have found the kinds of occupation most congenial to them. I am no believer in the industrial employment of women, by forcing them into employments where the labour is fully supplied by men. The point cannot be forced. Some instances may be found where men are in their wrong position, when women should be employed; but it is a complete fallacy to suppose that you can place women, industrially, wherever you think right, without the will of the public and the concurrence of the masters. These things regulate themselves;

and, with the pressure of female labour in the market, women would have forced men out of occupation fitted for them long ago, if they were better suited for such particular occupations than men. Many weak arguments have been used in this good cause, but the whole question is more a fundamental one than is generally imagined. We must restore the balance of female life, and put woman, as far as possible, in her true place—as the helpmate of man, not as a competitor for toil and labour.

"Marriage is woman's true mission, and it should be part of our great scheme of reformation to keep her in that position as much as possible.

"But how stands Scotland in respect to 'marriage?' Lamentable is her case, indeed, as compared with England. The tables I have given for England and Scotland illustrate this fully; and by reference to them you will find, that while in England the marriages in 1857 were as ·824 to 100 inhabitants, the proportion in Scotland in 1859 was only ·676 to the same number. Again, the marriages in Scotland were later in life, and therefore less favourable to that moral condition which early marriage creates, fosters, and perpetuates. The following are the figures:—

Average Ages of Persons Marrying out of every 100 *Married.*

	England. 1859.	Scotland. 1856.
Males under 20 years of age, .	2·637	3·086
" under 25 " .	49·544	40·790
" under 30 " .	75·254	70·166
" above 30 " .	24·746	30·834
Females under 20 years of age, .	13·224	12·565
" under 25 " .	62·631	58·416
" under 30 " .	82·430	82·708
" above 30 " .	17·570	17·292

"These results are for single years; but, one year with another, the results will be found much the same.

"No doubt, where two countries approximate, or rather join each other, speaking the same language, and living under the same laws, the richer country will attract the male population to engage in trade, &c.; and this element must be kept in view in comparing Scotland and England; but it does not affect the question I am now putting, except in so far as Scotchmen wandering to England may prefer an English to a Scotch wife. But I would deduce from these figures, and from observations made otherwise, the benefits of early marriages.

"But these remedies are all systematic, requiring time to develop them; meanwhile, the evil which we find prevails amongst us should be promptly met by remedial measures. It is a difficult matter to suggest remedies for immediate relief, seeing how fundamentally our system is deranged; but, at the risk of being charged with over-zeal, I shall venture to make a few suggestions.

"*1st*, then, An illegitimate child should be under the supervision of the parochial authorities, whether the parents can support it or not, and each county should be assessed for these children as far as not supported by the parents by a separate assessment. By advocating that illegitimate children should be under the immediate supervision of the parochial authorities, I do not mean that they should be supported by the parish when the parents can do so, but I mean that the fate of each child born out of wedlock in the parish should be carefully watched, even although it entailed more expense and responsibility than at present. It may be argued, that by placing more responsibility on the parochial authorities than at present we would increase the evil; but even if such were at first the tendency, I am firmly convinced that child-murder* would be less common when the parochial authorities had cognizance of such children, while the burden thrown on the landlords would rouse them not only to attend more to the position of the labouring class around them, but would be an inducement to them to urge the clergy to be fully alive to the spread of laxity of morals throughout their parishes, thereby ultimately securing a better state of things.

"*2d*, Our clergy ought to be much in the houses of their parishioners; not as mere formal visitors, but as the best and nearest

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* By a return made to the House of Commons in 1861, it appeared that from 31st December 1855 to 31st December 1860, the number of coroners' inquests held upon the bodies of infants within the Metropolitan District (London) alone were 3901,—namely, on males, 2082; females, 1816; sex unknown, 3.

friends of the family—the physicians of their souls. Unless the minister is the kind and affectionate father of his parishioners, following his avocation day by day, making his religion a daily work, one great source of aid in putting down such evils as are prevalent in Scotland must be awanting.

"3*d*, To the landed proprietor—to the manufacturer—to all masters and mistresses, we must appeal for aid.

"To the landed proprietor we would say, instead of bothies for males and females, let all single men and women be boarded, if possible, with the married couples, giving sufficient room to keep all pure; or let there be separate houses for men and women, where they may mess and live together under some superintendence.

"We might also, under this head, appeal to the heavy charge for poor-rate as an argument for exertion on the part of all who are taxed.

"I have before me a set of tables, issued by the Poor-Law Board, giving an account of the number of paupers in 646 unions and parishes at the end of the first half year of 1860.

"There were 162,337 men, 357,271 women, 289,587 children under 16, and 1737 vagrants; the men thus forming 20 per cent., the women 44·1, the children 35·7. Of these 338,497 are described as able-bodied (including the children of the able-bodied); and concerning 303,797 of these, information is supplied by 629 unions of the causes which brought them on the poor-rates.

Causes which brought 303,797 *Persons on the Poor-Rate, Scotland.*

		Men.	Women.	Children.
1. Widowhood—Widows,		...	49,232	...
Children dependent on them,		...	...	123,646
2. Families dependent on Males in Classes 3, 4, and 5—Wives,		...	19,648	...
Children,		...	...	51,294
3. Sickness, accident, or infirmity—				
Their own,	16,116	...	...	...
That of any of the family or a funeral,	7,376	...	...	...
		23,492	...	...
4. Husbands non-resident,		...	3,867	10,102
5. Husbands in jail, &c.,		...	1,568	4,470
6. Bastardy—Mothers,		...	2,122	...
Children,		...	...	3,261
7. Husbands in the army or navy—				
Wives,		...	1,435	...
Children,		...	...	3,407
8. Single women without children,		...	5,267	...
9. Want of work and other causes,		869	...	...
10. Sudden and urgent necessity,		117	...	...
		24,478	83,109	196,180

"*4th*, To mistresses, and the female sex in general, whether of high or low degree, we must look for great aid in this work of reform.

"We must now return to our second head,—namely, the loss of male life.

"I have already shown you the diseases of which men die in greater proportion than women. These are—congenital diseases, atrophy, debility, kidney disease, delirium tremens, apoplexy, paralysis, convulsions, and diseases of the brain, bronchitis, pleurisy, pneumonia, asthma, accident, suicide, and a long list of others, most of them arising from a depraved constitution and exposure, aggravated in many instances by bad habits, and transmitted, through the effects of such habits, by the male to his male children, whose conformation render them, I understand from medical men, more susceptible of disease in infancy. If man would reflect that his diseases, and I may add his habits and their constitutional effects, may be transmitted through many generations, he would surely pause in his career, for such constitutional effects are greatly the causes of the great mortality in early life. This mortality in Great Britain, and in all countries where it obtains, is a national sin, and to it the attention of philanthropists, and all men anxious to benefit their race, should be directed.

"I have not touched on sanitary defects, as they apply to both male and female, but to that point also attention is urgently required.

"The drain upon the country by foreign wars is not to be forgotten among other causes which consume our male population. War, I am afraid, we must acknowledge as a necessity, but if that were the only drain upon our resources, we could, by the natural law of birth, meet it; and may it not be said that the greater number of male children born than female is to meet the decrement arising from accident and war.

"But to revert to the original statements with which I started:—

"In Scotland, at last census, there were

	1,614,269	females
and	1,446,982	males
	167,287	excess of females.

An army of male lives has thus disappeared, without taking into account the difference of 5 per cent. with which the males originally started.

"In England and Wales, at last census, there were

	10,302,873	females
and	9,758,852	males
	551,021	excess of females.

Upwards of half a million males lost, without taking into account the original 5 per cent in favour of male life.

"These two differences show what we have thrown away by premature death among males, and what we have lost by emigration, allowing 5 per cent. to stand for casualties to which men are exposed by war and otherwise. A lamentable conclusion, and particularly so as regards Scotland.

4. On the Danger of Hasty Generalisation in Geology. By Alexander Bryson, Esq.

5. On the Deflection of the Plummet caused by the Sun's and Moon's Attraction. By Edward Sang.

In this paper it was shown that the attraction of the sun causes a deflection of the plummet, having its maximum about the 240th part of a second, and proportional to the size of twice the sun's zenith distance; the deflection is at its maximum when the sun is 45° above or below the horizon, and occurs in the vertical plane passing through the attracting body.

The deflection due to the moon has its maximum about the 60th part of a second, and follows the same law; it is toward or from the attracting body according as the zenith distance is less or more than 90°.

Upon the cross-level of a transit instrument, the joint effect is to cause a semi-diurnal oscillation small at the quarters and rising to the 24th part of a second at new and full moon; while the influence upon meridian observations is sufficient to cause a disagreement between the greatest inclination of the moon's orbit, as observed at St Petersburg and Madras, amounting to the 50th of a second.

The general conclusion drawn was, that we cannot determine the positions of the heavenly bodies true to the 100th part of a second without having made allowance for this source of disturbance.

6. Note on Gravity and Cohesion. By Professor William Thomson.

The view, founded on Boscovich's theory, commonly taken of cohesion, whether of solids or of liquids, is, that it results from a force of attraction between the particles of matter, which increases much more rapidly than according to the inverse square of the distance, when the distance is diminished below some very small limit. This view might, indeed, seem inevitable, unless the idea of "attraction" is to be discarded altogether; because the law of attraction at sensible distances—the Newtonian law—demonstrated by its discoverer for distances not incomparably smaller than the earth's dimensions, and verified by Maskelyne and Cavendish in a manner rendering it impossible for any naturalist to reasonably doubt its applicability to the mutual action between particles a few hundred yards or a few inches asunder, seems to give only very small, scarcely appreciable, forces between bodies of such masses as those we experiment on in our laboratories, everywhere placed as close as possible to one another,—that is to say, in contact, and does not seem to provide for any considerable increase of attraction when the area of contact is increased, whether by pressing the bodies together, or by shaping them to fit over a large area.

But if we take into account the heterogeneous distribution of density essential to any molecular theory of matter, we readily see that it alone is sufficient to intensify the force of gravitation between two bodies placed extremely close to one another, or between two parts of one body, and therefore that cohesion may be accounted for without assuming any other force than that of gravitation, or any other law than the Newtonian. To prove this, let two homogeneous cubes be placed with one side of each in perfect contact with one side of the other; and let one-third of the matter of each cube be condensed into a very great number, i, of square bars perpendicular to the common face of the two; and let the other two-thirds of the matter be removed for the present. The mass of each bar will be $\frac{1}{3i}$ of the whole mass originally given in each cube.

Let us farther suppose that the two groups of bars are placed so that each bar of one group has an end in complete contact with an end of a bar of the other. The attraction between each two such conterminous bars, however small their masses are, may be increased without limit, by diminishing the area of its section, and keeping its mass constant. But the whole mutual attraction between the two groups exceeds i times the attraction between each of the conterminous pairs, and may therefore be made to have any value, however great, merely by condensing each bar in its transverse section, and keeping their number and the mass of each constant.

We may now suppose another third of the whole mass to be condensed into bars parallel to another side of the cube, and the remaining third into bars parallel to the remaining side. If, then, either of these cubes be placed with any side in contact with any side of the other, and allowed to take the relative position to which it will obviously tend—that in which the bars perpendicular to the common side of the two cubes come together end to end, there will be produced, by pure gravitation, a force of attraction between them which may be of any amount, however great, and which will be greater, the greater the ratio of the whole space unoccupied within the boundary of either cube, to the space occupied by the matter of the bars.

This illustration has been chosen merely for the sake of definiteness and simplicity; but it is clear that any arrangement, however complex, of woven fibrous structure, provided only the ratio of the unoccupied to the occupied space is sufficiently great, will lead to the same general conclusion. Farther, it is clear that the same result would be produced by any sufficiently intense heterogeneousness of structure whatever, provided only some appreciable proportion of the whole mass is so condensed in a continuous space in the interior that it is possible, from any point of this space as centre, to describe a spherical surface which shall contain a very much greater amount of matter than the proportion of the whole matter of the body which would correspond to its volume. Except in imposing this condition, the theory now suggested interferes with no molecular hypothesis hitherto propounded, continuous or atomic, finite atoms, or centres of force, static or kinetic.

Physical science abounds with evidence that there is an ultimate very intense heterogeneousness in the constitution of matter. All that is valid of the unfortunately so-called "atomic" theory of chemistry seems to be an assumption of such heterogeneousness in explaining the combination of substances. This alone, it is true, does not explain the law of definite combining proportions; but neither does the hypothesis of infinitely strong finite pieces of matter; and whatever is assumed to be the structural character of a chemical compound, a dynamical law of affinity between the two substances, according to the proportions of them lying or moving beside one another, must be added to do what some writers seem to suppose done by their "atomic theory."

It is satisfactory to find that, so far as cohesion is concerned, no other force than that of gravitation need be assumed.

The following Donations to the Library were announced:—

On Binocular Vision and the Stereoscope: a Lecture by William B. Carpenter, M.D., &c. 12mo.—*From the Author.*

Description of a New Species of Clerodendron from Old Calabar, which flowered in 1861 in the Royal Botanic Garden of Edinburgh. By John Hutton Balfour, A.M., M.D., &c. 8vo. —*From the Author.*

Abstract of the Proceedings of the Geological Society of London, Nos. 78, 79, 80.—*From the Society.*

Man and his Helpmate. By William Thomas Thomson. Folio. *From the Author.*

Monthly Return of the Births, Deaths, and Marriages Registered in the Eight Principal Towns of Scotland. March 1862. 8vo. —*From the Registrar-General.*

Monthly Notices of the Royal Astronomical Society. Vol. XXII. No. 5. 8vo.—*From the Society.*

Journal of the Chemical Society. No. LX. 8vo.—*From the Society.*

Monday, 28*th April* 1862.

PROFESSOR CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. Experimental Inquiry into the Laws of the Conduction of Heat in Bars, and into the Conducting Power of Wrought Iron. By Principal Forbes.

The experiments described in this paper were all made in 1850 and 1851, upon a plan which was fully explained by the author in letters to Mr Airy and Professor Kelland in the former year. Some notice of them appeared in the British Association Reports for 1851 and 1852, and the apparatus was supplied by a grant from the Association.

In previous inquiries into the thermal condition of a long conducting bar heated at one end, two assumptions have always been made: *First*, that the flux of heat across any transverse section of the bar is proportional throughout to the rapidity of the decrement of temperature reckoned along the axis of the bar (or to $\frac{dv}{dx}$, where v represents the temperature, above that of surrounding space, of any point of the axis of the bar at a distance x from the origin). *Secondly*, That the loss of heat by radiation and convection from the surface of the bar is at every point proportional to the same temperature v. By assuming these principles (the last of which is certainly more or less inexact), the well-known solution of the problem of the heated bar is, that the temperatures (or excesses of temperature) diminish in a geometrical progression from the origin, and finally, of course, become insensible. Previous experimenters have confined themselves to finding the constants of the logarithmic curve for different substances, and thence their *relative* (not absolute) conducting powers.

In the experiments now described, neither of the above-mentioned principles is assumed. The external loss of heat is *directly* ascertained by experiment, and the admissibility or otherwise of the former principle is also *directly* tested. That principle may be thus symbolised: $F = -k\frac{dv}{dx}$, where F is the flux of heat across unit of section, k the conducting power for the substance employed, and v and x have the same signification as before.

I. In the first instance, a bar of iron 8 feet long and 1¼ inch in diameter, was heated by means of a crucible at one end, containing melted solder. Thermometers were inserted at various points of its length. The results, v in terms of x, were projected in a curve (approximately a logarithmic), and the values of $\frac{dv}{dx}$ were found by projection or calculation, or both.

II. Next a short bar (20 inches long), perfectly similar in section and condition of surface to the long bar, is heated to above 200° Cent. in a bath of fusible metal, and allowed to cool in free space, a thermometer being inserted at the centre of its length. This gives us the *rate at which such a bar is parting with its heat from all causes whatever*, in terms of the temperature shown by a thermometer in its axis.

III. The losses of heat in unit of time (one minute) last found may be taken as representing the amount of heat dissipated from each point of the long bar in the statical experiment (I.), being given in terms of the temperature proper to each point of such a bar. A curve may thus be constructed, having for its line of abscissæ the axis of the long bar, and for ordinates, the rate of dissipation of heat from each portion of its surface due to both radiation and convection.

IV. If we can by mechanical quadrature, or otherwise, find the whole amount of heat dissipated between any point of the long bar and its coolest extremity, we have, in truth, the flux of heat passing from the hotter extremity of the body across the particular section in question; for the condition of permanence of the temperature of the bar arises from the equality of the heat supplied and dissipated. But the whole heat dissipated in unit of time is the integral of the partial dissipations represented by vertical ordinates of the last-named curve, taken between any assumed point x and the farthest or cool end of the bar. This quantity, then, is F or the flux across unit of section at the point x.

V. We are now able to resolve the question whether or not the flux of heat is in the given bar everywhere proportional to the rapidity with which the temperature decreases as x increases, or whether the equation holds, $F = -k\frac{dv}{dx}$, the conducting power k being supposed to be constant.

The following table (the result of an *approximate* reduction made in 1852) shows that the constancy of k in the case of iron cannot be assumed; on the contrary, that the conductivity diminishes as the temperature increases. The first column is the observed temperature of given points of the bars; the second and third columns give the values of k from the preceding equation—(1.) as deduced from experiments on the iron bar with a polished surface; (2.) when the surface was covered with thin paper. The general coincidence of the two is satisfactory, since the external cooling was considerably different in the two cases.

Actual Temperature, Centigrade.	$\frac{F}{-\frac{dv}{dx}}$; polished bar.	$\frac{F}{-\frac{dv}{dx}}$; covered bar.
25°	·0136	·0147
50	·0130	·0138
75	·0131	·0123
100	·0126	·0113
125	·0122	·0107
150	·0112	·0107
175	·0100	·0102
200	·0087	...

The mean of both series may be tolerably represented by a uniformly diminishing conductivity as the temperature increases. When reduced* to the usual units of conducting power expressed in terms of the amount of heat necessary to raise by 1° Centigrade a cubic foot or a cubic centimètre (one gramme) of water respectively, we have the following absolute measures :—

Temperature, Centigrade.	Conducting Power of Wrought Iron.	
	Units, the Foot, Minute, and Cent. Degree.	Units, the Centimètre, Minute and Cent. Degree.
0°	·0133	12·36
50	·0120	11·15
100	·0107	9·94
150	·0094	8·73
200	·0082	7·62

It is to be observed that thermometric readings have not yet been finally corrected, so that these numbers may receive some slight modification. The author hopes to complete the verification of the calculations, so far as wrought iron is concerned, in the course of the present summer. The state of his health has been the cause, not only of the suspension of the experiments, but of the long delay which has taken place in publishing the results so far as obtained.

2. On Certain Vegetable Formations in Calcareous Spar. By Principal Sir David Brewster.

3. On the Existence of *Acari* between the Laminæ of Mica in Optical Contact. By Principal Sir David Brewster.

4. On the Secular Cooling of the Earth. By Professor William Thomson.

The fact that the temperature of the earth increases with the depth below the surface, implies a continual loss of heat from the interior by conduction outwards, through or into the upper crust. Since the upper crust does not become hotter from year to year, there must therefore be a secular loss of heat from the whole earth. It is possible that no cooling may result from this loss of heat, but

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* The numbers in the preceding table refer to the thermal capacity of iron instead of water.

only exhaustion of potential energy, which in this case could scarcely be other than chemical affinity between substances forming part of the earth's mass. But it is certain that either the earth is becoming, on the whole, cooler from age to age, or that the heat conducted out is generated in the interior by temporary dynamical action (such as chemical combination). To suppose, as Lyell has done,* that the substances combining together, according to the chemical hypothesis of terrestrial heat, may be again separated electrolytically by thermo-electric currents due to the heat generated by their combination, and thus the chemical action and its heat continued in an endless cycle, violates the first principles of natural philosophy in exactly the same manner and to the same degree, as to believe that a clock constructed with a self-winding movement may fulfil the expectations of its ingenious inventor by going for ever.

Adopting as the more probable, the simpler hypothesis that the earth is merely a heated body cooling, and not, on the whole, influenced to any sensible degree by interior chemical action, the author applies Fourier's theory of the conduction of heat to trace the earth's thermal history backwards. From data regarding the specific heat and thermal conductivity of the earth's substance, he investigates the time that must elapse from an epoch of any given uniform high temperature throughout the interior, until the present condition of underground temperature could be reached. Taking into account the very uncertain character of the data when high temperatures are concerned, he infers that most probably either the whole earth must have been incandescent at some time from 50,000,000 to 500,000,000 years ago, or that at some less ancient date, but still anterior to the earliest human history, there must have been up to the surface a temperature above the boiling-point of water. Either alternative—or indeed any theory whatever consistent with the principles of natural philosophy regarding previous conditions of the earth—is as decisive against the views of those naturalists who acknowledge no creation of life on the earth within fathomable periods of time, as the plainest elements of dynamics are against those who maintain that we have no evidence in nature of an end.

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* Principles of Geology.

5. Notice of the Ravages of the *Limnoria Terebrans* on Creosoted Timber. By David Stevenson, Esq., F.R.S.E., M.I.C.E., &c.

The author stated that it would be difficult to estimate the value of any chemical or mechanical process whereby timber might be rendered permanently impervious to the ravages of the *Limnoria terebrans*, that small but sure destroyer of timber structures exposed to the action of the sea.

The ravages of that crustacean were first observed in 1810 by Mr Robert Stevenson, the engineer of the Bell Rock Lighthouse, in the timber supports of the temporary beacon used by him in the erection of that work. Having forwarded specimens of the insect, and of the timber it had destroyed, to Dr Leach, the eminent Naturalist of the British Museum, Dr Leach, in 1811, announced it as a "new and highly interesting species which had been sent to him by his friend Robert Stevenson, civil engineer," and assigned to it the name of *Limnoria terebrans* (Linnean Trans., vol. xi. p. 370, and Edinburgh Encyclopædia, vol. vii. p. 433).

The *Teredo navalis*, which was a larger and even more destructive enemy, was happily not so prevalent in northern seas as the Limnoria.

Experiments made at the Bell Rock by Mr Robert Stevenson, extending over a period of nearly thirty years, the detailed account of which was given in Mr Thomas Stevenson's article on Harbours in the "Encyclopædia Britannica," had clearly proved that teak, African oak, English and American oak, mahogany, beech, ash, elm, and the different varieties of pine, were found sooner or later to become a prey to the Limnoria. Greenheart oak was alone found to withstand their attacks; and even this timber was said in some instances to have failed.

Mr Stevenson's experiments also included the testing of the artificial processes of Kyan and Payne, the former being an injection of corrosive sublimate, and the latter of proto-sulphate of iron. Timber prepared by Kyan's process was attacked in two years and four months, and in four years and seven months was quite destroyed. Timber prepared by Payne's process was attacked in ten months, and destroyed in one year and ten months.

The justly approved creosote process, patented by Mr Bethell, had been largely employed in railway works, with universally admitted success, and, in common with many of his professional brethren, the author adopted it in several marine works, in the expectation that it would prove an antidote to the Limnoria; but having now ascertained beyond all doubt that creosote was not a universal or permanent preservative of timber used in marine works, the author proposed, in the present notice, to state briefly the facts on which this opinion was grounded.

Before doing so, however, he wished it to be distinctly understood that he did not undervalue Mr Bethell's highly important invention as a preservative of timber against all ordinary decay incident to railway sleepers, timber viaducts, and, indeed, all timber structures not exposed to sea-water infested with the *Limnoria terebrans.* His remarks referred exclusively to its application for marine works below half-tide level. For all other classes of works, he believed it to be a most valuable preservative.

In 1859, in a discussion which followed a paper on the "Permanent Way of the Madras Railway," at the Institution of Civil Engineers, the author first stated that there were distinct evidences of the attack of the *Limnoria terebrans* on creosoted timber used at Scrabster Harbour in Caithness; while Mr Bethell, the patentee, and others, expressed their conviction that creosoted timber could not be perforated by any worm or insect.

Subsequent experience and observation have satisfied the author that the statement which he then made was correct, the fact, as now ascertained, being that thoroughly creosoted timber is, in certain situations, readily perforated by the Limnoria Terebrans.

The first instance to which he referred was the pier at Leith, which was executed about 1850, by the late Mr Rendel. The whole of the timber employed was creosoted on the spot in the most careful manner. As the piers at Leith were washed by a constant admixture of fresh water from the water of Leith, the author expected that the progress of devastation at that place would be so slow as to be hardly appreciable on creosoted timber. But having carefully examined the West Pier, he corroborated the evidence given by Mr A. M. Rendel in 1860, before the Select Committee on Leith Docks' Bill, that, notwithstanding the most careful application of creosote, the timber work has been attacked by the insect to a great extent.

The second case to which he referred was Invergordon. Two steamboat jetties were constructed at that place from designs by Messrs Stevenson. It was generally represented that there were little or no traces of marine insects in the Cromarty Frith, and it was resolved that it was a situation peculiarly suitable for employing timber pile-work protected by creosote. The timber used in the work was carefully selected at Leith, and dressed to the necessary scantlings and lengths, so as to avoid all cutting after it had undergone the process of creosoting. It was then creosoted by an agent sent by Mr Bethell for the purpose, at the sight of a careful inspector employed by the engineers. Every piece of timber was weighed before being put into the tank, and the process of creosoting was continued until each piece had received, as nearly as possible, the specified quantity of 10 lbs. of oil per cubic foot. Some experimental pieces were from time to time cut longitudinally, when it was found that the creosote had entered the ends of the logs 18 inches to 2 feet, and that it had saturated the timber some two or more inches all round. No greater precautions could possibly be used to insure perfection in carrying out the process, which involved an additional cost of about L.450. The jetties were erected in 1858, and now the Superintendent's report was, "that the blackened or creosoted portion of the timber is very much eaten and perforated. The timber perforated is just as it came from the creosoting tank, never having been cut. There is 1¼ inch wasted on some of the piles that have been perforated."

The third case to which he referred was Scrabster, which was also constructed under Messrs Stevenson's directions. The timber employed in this instance was selected Memel of first-rate quality; it was carefully creosoted at Glasgow. On cutting up a timber that had been attacked by the Limnoria, it was found that the creosote had fully entered at the ends, and saturated the sides, and yet it was discovered to have been attacked after it had only been exposed thirteen months,—the insect perforating the blackened timber. The whole of the creosoted portion of the timber work was now more or less worm-eaten and destroyed. Mr Leslie had also directed the author's attention to similar results at Granton and Stranraer, at both of which places the creosoted timber had been perforated.

The author held that these instances were enough to prove that the failure was not peculiar to one spot or one isolated case. If it was said that the timber used at these places had not been *properly* creosoted, it might fairly be concluded, that if the process, even when conducted in the patentee's own works, to the satisfaction of careful inspectors, was so difficult and uncertain in its results, its general applicability would be greatly injured. All newly creosoted timber, whether it was well or ill done, presented the same appearance externally; and it was only by weight that the completeness of the saturation could be judged of; and if careful weighing before and after the timber had been creosoted was not to be held as an ample and satisfactory test that the process had been properly conducted, it seemed hopeless to expect that perfect satisfaction could be attained. But it was so far fortunate for Mr Bethell's system, that it was not needful in the cases to which allusion had been made to call in question the extent of saturation which his process secured when properly executed. The timber at Scrabster and Invergordon, and he believed at the other places named, was undoubtedly thoroughly and properly saturated, and the author said that the explanation of the failure was to be found in the fact, that the Limnoria *perforated timber which had been thoroughly creosoted and blackened*—a fact which at once disproved the assumption, hitherto so generally made, that the poisonous nature of the creosote would prevent the insect from attacking it. As the Pholas perforated stone to procure shelter, the Limnoria might excavate timber for the same purpose, and obtain its food from the minute animalculæ with which the water of the ocean was charged. Dr Coldstream, in his elaborate paper on the Limnoria in the "Edinburgh New Philosophical Journal" for April 1834, had concluded that the Limnoria fed on the timber, and not on animal substances; but even if this were so, there seemed no reason to conclude that creosoted timber could not be eaten by insects, on account of the poisonous nature of the preparation employed. The author stated, that it had been ascertained that there were insects that lived and fattened on food that was to man a deadly poison. In the "British Medical Journal" for April 1862, there was an interesting notice on the subject. Mr Attfield had there shown that substances which are intensely poisonous to the higher animals do not affect *Acari*, which he found not only readily ate, but actually fattened on, strychnine, morphine, and other deadly poisons. But the author stated that the specimens which he laid before the Society proved conclusively that creosote does not act as a poison in preserving the timber, because it could be seen that the Limnoria were embedded in wood still highly charged with creosote.

After carefully considering the subject, the author had no doubt that the process of creosoting preserved timber from the attack of marine insects only so long as the oil existed as a film or coating on the outside of the timber. Whenever the attrition caused by the motion of the sea removed this outer film or coating, and exposed the fibrous surface of the timber, the insect would then attack and perforate it, whether it were creosoted or not, its search being for a fibrous substance in which to burrow. The time that might elapse before the timber became assailable to these insects depended on the situation. Wherever there was little abrading action of the sea, the exterior film of creosote might be longer preserved; and where there was a considerable admixture of fresh water to check the growth, or at least the avidity of the insect, the effect of their ravages might be more gradual, or, in some situations, almost inappreciable. But the result of the author's observation and experience led him irresistibly to the conclusion, that on the northern shores of the country, where works are exposed to the open sea, creosoted timber was readily perforated by the Limnoria, and could not be safely employed in any important part of a marine structure at or below half-tide level, a fact of great importance to the civil engineer.

6. On some Thermic Properties of Water and Steam. By Professor W. J. Macquorn Rankine.

The author refers to the general equation of the mechanical action of heat which Professor Clausius and he arrived at independently by different methods in 1849, and points out that the form of that equation, which was laid before the Society by him in a paper read on the 4th of February 1850, comprehends, as a particular case, the law which connects the volume of a given weight of steam with its temperature, pressure, and latent heat. He describes the use of that law, with proper numerical data, to compute, in the absence of direct experiment, tables of the density and volume of saturated steam, more accurate than those founded on the assumption of the perfectly gaseous condition, as exemplified in tables which he published in 1855 and subsequently. Referring next to the direct experiments of Messrs Fairbairn and Tate on the density of steam, published in the Philosophical Transactions for 1860, he gives a tabular comparison of the volumes of one pound of steam as determined by these experiments, and as computed theoretically from M. Regnault's experiments on the latent heat of steam, with the aid of Joule's mechanical equivalent of heat; and from that comparison he draws conclusions which may be summed up as follows:—

1. At temperatures below 212°, the differences between the results of theory and experiment are inappreciable.

2. At temperatures above 212°, the differences, although too small to be of any consequence in practical calculations connected with steam-engines, are appreciable, the volume of a pound of steam by theory being slightly greater than by experiment.

3. Small as those differences are, there exist no known sources of error either in the data of the theoretical calculation or in the method of experimenting sufficient to account for them.

4. They are therefore most probably caused by some unknown difference in the molecular condition of the steam in M. Regnault's experiments on latent heat, and in Messrs Fairbairn and Tate's experiments on density.

5. That difference of condition is probably connected with the fact, that in M. Regnault's experiments the steam was in rapid motion from a boiler towards a condenser; whereas in the experiments of Messrs Fairbairn and Tate the steam was at rest.

6. Further experimental researches are desirable.

7. Formulæ connected with small continuous Displacements of the Particles of a Medium. By Professor Tait.

Although most of the results deduced in this Note have been long known, I venture to offer it to the Society on account of the extreme simplicity of the analysis employed, and the consequent insight it affords us into the connection of various formulæ. I intend on a future occasion to give large further developments especially bearing on physics. I employ the calculus of quaternions throughout, but where some unusual expressions occur, I have given them in their common Cartesian form, as well as in the quaternion one.

I. $$\text{If } F\rho = C \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

be the equation to one of a system of surfaces, and if the differential of (1) be

$$S.\nu d\rho = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2),$$

ν is a vector perpendicular to the surface, and its length is inversely proportional to the normal distance between two consecutive surfaces. In fact (2) shows that ν is perpendicular to $d\rho$, which is any tangent vector, thus proving the first assertion. Also, since in passing to a proximate surface we may write

$$S.\nu\delta\rho = \delta C, \text{ we see that}$$
$$F(\rho + \nu^{-1}\delta C) = C + \delta C.$$

This proves the latter assertion.

It is evident from the above that if (1) be an equipotential, or an isothermal, surface, $-\nu$ represents in direction and magnitude the force at any point or the flux of heat. And we see at once that if

$$\triangleleft = i\frac{d}{dx} + j\frac{d}{dy} + k\frac{d}{dz} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3),$$

giving $$\triangleleft^2 = -\frac{d^2}{dx^2} - \frac{d^2}{dy^2} - \frac{d^2}{dz^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)^1,$$

$$\text{then } \nu = \triangleleft F\rho. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4).$$

This is due to Sir W. R. Hamilton (*Lectures on Quaternions*, p. 611).

From this it follows that *the effect of the vector operation $\triangleleft$ upon any scalar function of the vector of a point is to produce the vector which represents in magnitude and direction the most rapid change in the value of the function.*

Let us next consider the effect of $\triangleleft$ upon a *vector* as

$$\sigma = i\xi + j\eta + k\zeta \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5).$$

We have at once

$$\triangleleft\sigma = -\left(\frac{d\xi}{dx} + \frac{d\eta}{dy} + \frac{d\zeta}{dz}\right) - i\left(\frac{d\eta}{dz} - \frac{d\zeta}{dy}\right) - \&c. \quad . \quad (6),$$

and in this semi-Cartesian form it is easy to see that—

If σ represent a small vector displacement of a point situated at the extremity of the vector ρ (drawn from the origin)

$S\,.\triangleleft\,\sigma$ *represents the consequent cubical compression of the group of points in the vicinity of that considered, and*

$V\,.\triangleleft\,\sigma$ *represents twice the vector axis of rotation of the same group of points.*

Similarly

$$S\,.\,\sigma\triangleleft = -\left(\xi\frac{d}{dx} + \eta\frac{d}{dy} + \zeta\frac{d}{dz}\right) = -D_{\sigma} \quad . \quad . \quad (7),$$

or *is equivalent to total differentiation in virtue of our having passed from one end to the other of the vector* σ.

The interpretation of $V\,.\,\sigma\triangleleft$ is also easy enough, but it is not required for the present investigation.

II. Suppose we fix our attention upon a group of points which originally filled a small sphere about the extremity of ρ as centre, whose equation referred to that point is

$$T\omega = e \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8).$$

After displacement ρ becomes $\rho + \sigma$, and by (7) $\rho + \omega$ becomes $\rho + \omega + \sigma - (S\,.\,\omega\triangleleft\,)\sigma$. Hence the vector of the new surface which encloses the group of points (drawn from the extremity of $\rho + \sigma$), is

$$\omega_1 = \omega - (S\,.\,\omega\triangleleft\,)\sigma \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9).$$

Hence ω is a homogeneous linear and vector function of ω_1; or

$$\omega = \phi\omega_1$$

in Sir W. R. Hamilton's notation, and therefore by (8)

$$T\phi\omega_1 = e \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10),$$

the equation to *the new surface, which is evidently a central surface of the second order, and therefore, of course, an ellipsoid* (Cauchy—*Exercises*, vol. ii.).

We may solve (9) with great ease by approximation, if we remember that $T\sigma$ is very small, and therefore that in the small term we may put ω_1 for ω—*i.e.* omit squares of small quantities; thus,

$$\omega = \omega_1 + (S\,.\,\omega_1\triangleleft\,)\sigma \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11).$$

Or if we choose we may obtain the exact solution very easily. Operating on (9) with S . *i*, S . *j*, S . *k*, we get

$$S i\omega_1 = S\omega(i + \triangleleft\,\xi), \text{ &c.} = \text{&c.}$$

Hence
$$\omega\,S.(i+\triangleleft\,\xi)(j+\triangleleft\,\eta)(k+\triangleleft\,\zeta)=V.(j+\triangleleft\,\eta)(k+\triangleleft\,\zeta)Si\omega_1+\&c.$$
From this we may easily verify the former expression by emitting products of ξ, η, ζ.

Thus $$\omega(-1-h)=\left[i\,(1+h)-\frac{d\sigma}{dx}\right]Si\omega_1+\&c.+\&c.,$$

where $$h=\frac{d\xi}{dx}+\frac{d\eta}{dy}+\frac{d\zeta}{dz}.$$

Or $$\omega=-(iSi\omega_1+\&c.)+(S.\omega_1 i)\frac{d\sigma}{dx}+\&c.$$
$$=\omega_1+(S.\omega_1\triangleleft\,)\sigma \text{ as before,} \quad . \quad . \quad . \quad (11).$$

Thus it appears that the equation to the ellipsoid may be written
$$T\Big(\omega+(S\omega\triangleleft\,)\sigma\Big)=e \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10).$$

III. The differential of this equation is
$$S\Big(\omega+(S\omega\triangleleft\,)\sigma\Big)\Big(d\omega+(Sd\omega\triangleleft\,)\sigma\Big)=0,$$

whence, omitting the second order of small quantities, the normal vector is
$$\omega+(S\omega\triangleleft\,)\sigma+\triangleleft\,S\omega\sigma.$$

To find the axes we must therefore express that the latter is parallel to ω, or
$$p\omega=(S\omega\triangleleft\,)\sigma+\triangleleft\,S\omega\sigma \quad . \quad . \quad . \quad . \quad . \quad . \quad (12).$$

where p is an undetermined scalar.

The most obvious method of solving this equation is to operate in succession by $S.i$, $S.j$, and $S.k$. We thus obtain,
$$pSi\omega=S\omega\triangleleft\,Si\sigma+Si\triangleleft\,S\omega\sigma$$
$$\&c.=\&c.$$

Or, remembering (5),
$$S.\omega\left(pi+\triangleleft\,\xi+\frac{d\sigma}{dx}\right)=0,$$
$$\&c. \qquad =0,$$

p is therefore a root of the equation

$$S.\left(pi+\triangleleft\xi+\frac{d\sigma}{dx}\right)\left(pj+\triangleleft\eta+\frac{d\sigma}{dy}\right)\left(pk+\triangleleft\zeta+\frac{d\sigma}{dz}\right)=0.$$

or, as it may evidently be written,

$$\begin{vmatrix} p+2\dfrac{d\xi}{dx}, & \dfrac{d\xi}{dy}+\dfrac{d\eta}{dx}, & \dfrac{d\xi}{dz}+\dfrac{d\zeta}{dx} \\ \dfrac{d\xi}{dy}+\dfrac{d\eta}{dx}, & p+2\dfrac{d\eta}{dy}, & \dfrac{d\eta}{dz}+\dfrac{d\zeta}{dy} \\ \dfrac{d\xi}{dz}+\dfrac{d\zeta}{dx}, & \dfrac{d\eta}{dz}+\dfrac{d\zeta}{dy}, & p+2\dfrac{d\zeta}{dz} \end{vmatrix}=0. \quad . \ (13).$$

A value of p having been found from (13), the direction of the corresponding axis is given by

$$\omega \parallel V.\left(pi+\triangleleft\xi+\frac{d\sigma}{dx}\right)\left(pj+\triangleleft\eta+\frac{d\sigma}{dy}\right) \quad . \ . \ (14).$$

III. *a.* As a very simple example of distortion, suppose ρ to represent the position of each particle with regard to a centre attracting according to Newton's law, and let σ the vector of distortion be a small constant multiple of the vector force. Then

$$\frac{m}{T\rho}=C \text{ (the potential).}$$

$$\text{Hence } \sigma=\frac{gm\rho}{T\rho^3}, \text{ where } g \text{ is very small,}$$

$\therefore$ when ρ becomes $\rho+\sigma$, $\rho+\omega$ becomes $\rho+\omega+\dfrac{gm(\rho+\omega)}{T(\rho+\omega)^3}$. As $T\omega$ is exceedingly small, this may be written

$$\rho+\omega+\frac{gm(\rho+\alpha)}{T\rho^3\left(1-3\dfrac{S\omega\rho}{T\rho^2}\right)}.$$

Hence $\omega_1=\omega+\dfrac{gm}{T\rho^3}\left(\omega+3\rho\dfrac{S\omega\rho}{T\rho^2}\right)$, and an originally spherical surface $T\omega=e$ (8) becomes after distortion approximately

$$T\left(\omega_1-\frac{gm}{T\rho^3}\left(\omega_1+3\rho\frac{S\omega_1\rho}{T\rho^2}\right)\right)=e,$$

a spheroid of revolution whose axis is ρ, as indeed is evident.

IV. In this latter case we see at once that $V.\triangleleft\sigma=0$, and it is easy to show that in general, *if the small displacement of each point of a medium is in the direction of, and proportional to, the* *attraction exerted at that point by any system of masses, the displacement is effected without rotation.* For if $F\rho = C$ be the potential surface, we have $S\sigma d\rho$ a complete differential—*i.e.*, in Cartesian co-ordinates $\xi dx + \eta dy + \zeta dz$ is a differential of three independent variables. Hence the vector axis of rotation $i\left(\frac{d\zeta}{dy} - \frac{d\eta}{dz}\right)$ + &c., vanishes by the vanishing of each of its constituents, or $V. \triangleleft \sigma = 0$.

Conversely, *if there be no rotation the displacements are in the direction of, and proportional to, the normal vectors to a series of surfaces.*

For

$$0 = V.d\rho V. \triangleleft \sigma = (Sd\rho \triangleleft)\sigma - \triangleleft S\sigma d\rho.$$

Now, of the two terms on the right, the first is a complete differential, since it may be written $-D_{d\rho}\sigma$ (see (7)), and therefore the remaining term must be so.

Thus, in a distorted system, there is no compression if

$$S. \triangleleft \sigma = 0,$$

and no rotation if $V. \triangleleft \sigma = 0$; and evidently *merely transference if $\sigma = \alpha =$ a constant vector*, which is one case of $\triangleleft \sigma = 0$.

In the important case of $\sigma = e \triangleleft F\rho$ there is evidently no rotation, since $\triangleleft \sigma = e \triangleleft^2 F\rho$ is evidently a scalar. In this case, then, there are only translation and compression, and the latter is at each point proportional to the density of a distribution of matter, which would give the potential $F\rho$. For if r be such density, we have at once $\triangleleft^2 F\rho = 4\pi r$ (see $(3)^1$). This suggests a host of physical analogies which we cannot enter upon at present.

V. Keeping still to the meaning of σ as the vector of displacement, as we have seen that $\triangleleft \sigma = s + \iota$, where s is the condensation of the particles near the extremity of ρ, and ι the doubled vector axis of rotation of the group—we may apply the vector operation a second time. Thus,

$$\triangleleft^2 \sigma = \triangleleft s + \triangleleft \iota.$$

Now, our former results enable us to assign meanings to these expressions. $\triangleleft s$ is the normal-vector to any of the surfaces of equal condensation. The scalar and vector parts of $\triangleleft \iota$ represent the compression, and the doubled-axis of the rotation, consequent on the displacement of each point through a space represented by ι. Also it is easy to see that $\triangleleft^2\sigma$ is a pure vector. Hence

$$S.\triangleleft V\triangleleft\sigma=0.$$

If therefore there be two similar media, and the particles of one be slightly displaced in a continuous manner—the particles of the other being displaced through vectors proportional to the rotations at each point in the first mass—this displacement takes place without condensation.

And, as $V.\triangleleft\triangleleft s=0$, we have the other result, that *if the particles of the second medium be displaced through vectors representing the direction and rate of most rapid change of compression in the first, such displacement will take place without rotation.* But this is merely another way of stating the first proposition in IV.—(Compare Thomson, "On a Mechanical Representation of Electric, Magnetic, and Galvanic Forces"—*Camb. and Dub. Math. Jour.*, vol. ii.; and Maxwell, "On Physical Lines of Force"—*Phil. Mag.*, 1861–62.)

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Abstract of Proceedings of the Geological Society of London. No. 81.—*From the Society.*

INDEX.

END OF VOLUME FOURTH.

PRINTED BY NEILL AND COMPANY, EDINBURGH.